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Elementary School Teacher's Beliefs, Organizational Change, and STEM Implementation: Factors Impacting Teacher Leadership

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Elementary School Teacher's Beliefs, Organizational Change, and STEM Implementation: Factors Impacting Teacher Leadership

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This is a true testament of the saying that we are greater together.

Dedication

I want to first dedicate this dissertation to Jesus Christ, my personal savior. Secondly, I want to affectionately dedicate this dissertation to my husband William and to my overly understanding children: Samiah, Nhiaja, and Kaleb. They have exhibited an enormous amount of patience, forgiveness, and love during this journey. I love all of you to infinity!

The hard work that helped me to arrive here; at this juncture which is earning this doctorate is immeasurable. Earning this doctorate is not solely for me but it is for my children, nieces, nephews, and other family members to show them that the sky is the limit.

“Hardships often prepare ordinary people for an extraordinary destiny.” - C.S. Lewis

Abstract

The purpose of this qualitative case study was to examine organizational change as it related to the implementation of STEM as perceived by elementary educators in an urban school in an urban city. The barriers, challenges and supports provided to teachers regarding STEM implementation in an urban school were investigated This study looked to include teachers and teacher leaders over a six-week period in an elementary school in a large urban School District., As a result of this study, some dialogue was generated in reference to STEM instructional practices and integration. Teachers also shared how they can increase change implementation or become improved as a result of this research. This school was identified for the research since it has been designated as one that is actively seeking the STEM School designation as are all of the schools in the cluster where this school resides. The reason this is important is because the teachers are the implementers of the change and how they see or perceive the change in instructional programming is incumbent upon the success of the outcome of the programming change.

Keywords: STEM, instructional programming, organizational change, barriers, teacher leadership

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Chapter 1: Introduction

The purpose of this study was to investigate elementary teachers' beliefs about change in instructional programming in a school in a large urban district. The reason this is important is because the teachers are the implementers of the change and how they see or perceive the change in instructional programming directly impacts the success of the programming change. The change this study advocated for is the implementation of STEM which is an acronym for Science, Technology, Engineering, and Mathematics with fidelity. STEM programs have been adopted by numerous programs as an important focus for renewed global competitiveness for the United States, but conceptions of what STEM entails often vary among stakeholders (Breiner et al., 2012). The International Technology and Engineering Educators Association defines STEM as a new trans-disciplinary subject in schools that integrates the disciplines of science, technology, engineering, and mathematics into a single course of study (Dugger, 2010). There is not a seemingly consistent definition of what STEM is. The context of this study is in a large urban charter school district, largely underserved students. This school has been designated as a school that is actively seeking the STEM School designation as are all of the schools in the cluster where this school resides. There was a large push both verbally and economically from the school district for the school to obtain the classification of being a STEM certified school by the state of Georgia. The purpose of this study was to identify the reasons why teachers are resistant to organizational change to instructional programming that can assist their students with critical thinking and offer a reflective piece in order to transform their thinking and actions.

STEM is a popular acronym that stands for Science, Technology, Engineering, and Mathematics. This acronym was coined in 2001 by Judith Ramaley who was director of the National Science Foundation's Education and Human Resources Division (Christenson, 2011). As a program, STEM has been adopted by several school systems as an important focus for renewed global competitiveness for the United States, but conceptions of what STEM entails often varies among stakeholders (Breiner, Harkness, Johnson, & Koehler, 2012). However, simply put, STEM is the focus on the use of Science, Technology, Engineering, and Mathematics to impact how students process information to create a competitive workforce in the world (Gonzalez, 2012).

Background of the Problem

The National Science Foundation (NSF) compared the level of innovation that was in the United States versus other countries (Lynn & Bates, 2018). According to the National Science Foundation's *Science and Engineering Indicators* 2018 report, released in January of 2018, the United States is the global leader in science and technology (S&T), “But the U.S. global share of S&T activities is declining as other nations -- especially China -- continue to rise” (Lynn & Bates, 2018, U.S.Patterns and Trends Section, p.47).

According to Gonzalez and Kuenzi (2012), funding by the NSF is based on the perception of benefit to the creation of a highly competitive workforce in the world. In other words, the primary reasoning behind funding for STEM education programs at the National Science Foundation relies on their perceived impact on the United States workforce, and through it, on U.S. economic competitiveness and national security (Lynn & Bates, 2018). In 2012, Gonzalez’s study concluded that the federal government should increase investments in STEM education across the education “pipeline” which encompasses pre-kindergarten to post-graduate education. The National Science Foundation NSF plays a key role in the federal STEM education portfolio. Gonzalez and Kuenzi (2012) also referred to the major implications that an overarching federal STEM education as a result of policymakers adopt as their goals. Current reform in science education and the push for STEM awareness by the Obama administration and nationally recognized foundations have emphasized projects and programs that encourage American youth to connect with STEM fields (DeJarnette, 2012).

The United States is widely believed to be performing poorly in STEM education, however, “The data paint a complicated picture. By some measures, U.S. students appear to be doing quite well” (Gonzalez & Kuenzi, 2012, 2). Lynn and Bates (2018) use NSF research to state that the United States is still the global leader in science and technology, but other countries such as China are catching up at a fast pace. There were increases in the number of students in STEM, but there are still concerns over academic achievement gaps between various groups and STEM teacher quality (Gonzalez & Kuenzi, 2012). Other concerns include rankings of U.S. students on international STEM assessments and the ability of the U.S. STEM education system to meet domestic demand for STEM labor (Gonzalez & Kuenzi, 2012).

Discussions about urban education and urban schools by their very nature must consider how students and their families grow, think, behave, and enact their identities as well as the inextricability of these identities to local context and to locations within place according to Gadsen and Dixon-Roman (2017). When urban students have a path to receiving a college education, they also will be committed to make the most of that opportunity and earn a college degree (Bonilla-Santiago, 2014). While minorities make up an increasing percentage of students in the United States, they continue to be underrepresented in STEM fields (Stone, 2019).

Statement of the Problem

The demands for a more rigorous classroom, have called for the development of the Common Core State Standards (CCSS) to help prepare students for college, career, and life (National Governors Association Center for Best Practices & Council of Chief State School

Officers [NGA/CCSSO], 2010). The adoption and implementation of these standards have necessitated a change in the instructional skills and dispositions required of the elementary teacher. As a result, one cluster of schools in an urban school district decided that they wanted their teachers to utilize STEM instructional practices so that the school can earn the STEM designation as outlined by noted behaviors by the state of Georgia. This designation suggests that the school is providing inquiry-based, hands on learning to students. The school district is also providing support and acknowledgement for this designation. The school district support was in the form of funding a STEM specialist for 2 years at each school. Schools that earn this designation are mentioned on the state website, recognized at the school district, and receive a banner to place at the school. Capraro, et. al (2016) state that a substantial body of research has demonstrated that professional development can benefit student achievement. In this one school, the teachers are receiving professional development in STEM instructional practices from the instructional coach and they are still not utilizing these practices on a daily basis. The schools in this particular cluster of schools are urban schools. There are urban schools that want to be designated as STEM schools by the state. STEM instructional practices enhance student's critical and creative thinking.

In one particular school that is an area concern, is it possible to accomplish the STEM designation in an urban school. The concern is because of some of the factors that come with urban schools such as student achievement levels and home life trauma. However, the school would like to as an urban school be recognized as a premier school in spite of it being an urban school. I want to find out, if there is buy in for the change in instructional practices and organizational change by the staff that has to implement the change with students.

As elementary teachers work to implement Next Generation Science Standards (NGSS) and Common Core State Standards (CCSS) in the classroom, it will be critical that these teachers integrate disciplinary content (Carter, Beachner, Orona, & Daugherty, 2016).

Bell, Urhahne, Schanze, and Ploetzner (2010) conceptualized such a set of activities, based on a literature review, that they call the “nine main processes of inquiry learning” (p.350). The nine processes include orienting and asking questions, hypothesis generation, planning, investigation, analysis and interpretation, model, conclusion and evaluation, communication, and prediction. The conceptualization of inquiry-based science as a set of activities has the advantage that it is immediately clear what students should learn: By being active in, for example, hypothesis generation, the students should improve their hypothesizing skills (Grob, Holmier, Labudde, 2017).

Fullan and Stiegelbauer (1991) identified three major factors that affect the implementation of educational change. These factors are characteristics of change, local characteristics, and external factors. The characteristics of change have local and external factors that contribute to it. The conceptual framework topics that was the basis for this study concern the theory of change. As a researcher, I explored the reasons that there was such an apparent resistance to change to STEM programming in this urban elementary school through the lens of Kotter’s Theory of change.

Kotter’s theory is an eight-step lens to look at the organizational change that an organization is going to implement. Kotter’s Change Theory is described as a theory that attempts to explain a reason for and the operation of successful initiatives (Kotter, 2012). Utilizing Kotter’s 8 Step Theory of Change model was the crux of this study as it lent itself to uncovering participants in various stages of the trajectory of organizational change.

Purpose of the Study

The main purpose of this study was to identify ways to be successful in the implementation of STEM in an urban setting. Teachers must be willing to integrate STEM in the curriculum, so it is important to address any issues holding teachers from achieving the success needed in a STEM program. It is important to understand any perceptions the teachers have presently because the integration of Science, Technology, Engineering, and Math (STEM) has become a way of teaching and learning in classrooms across the country.

There are trends in the United States educational system that share in the indication that American students are lagging behind many European and Asian countries in the specific content areas of reading, science, and especially mathematics (Hossain & Robinson, 2012). Public and private sectors were in deep collaboration in STEM education; policies and budgets focused on maximizing federal investment to increase student access and engagement in active, rigorous STEM learning experiences; and meaningful efforts to inspire and recognize young inventors, discoverers, and makers (obamawhitehouse.archives.gov).

In the last few years, there has been an apparent advocacy or STEM education from all aspects of teaching and learning, but teaching inquiry-based science is not a common approach that is used in elementary science classrooms today (Weiss, 2006). The encouragement to implement STEM has included fiduciary support and the evolution of several programs geared towards increasing STEM instruction in schools through the National Science Foundation (NSF). President Barack Obama made the improvement of STEM education a priority. Public and private sectors were in deep collaboration in STEM education; policies and budgets focused on maximizing federal investment to increase student access and engagement in active, rigorous

STEM learning experiences; and meaningful efforts to inspire and recognize young inventors, discoverers, and makers (Whitehouse.gov, 2009). This research provides the support that elementary students need earlier exposure to STEM. The thought of change is sometimes daunting for those who are very rigidly set in their ways (Kotter, 2012).

Research Questions

This case study will be guided by the following research questions:

1. How does Kotter's model impact teacher's implementation of STEM?
2. What are the support, challenges, and barriers to STEM implementation in an urban elementary school setting?

Definition of Terms:

Makerspace: A makerspace is a place that provides creative means that encourages students to design, use equipment, to build and invent as they deeply delve into technology, science, and engineering. It is not solely one kind of workshop, but it may contain elements found in a variety of familiar spaces (Cooper, 2013).

Mindset Thinking: teachers' attitudes, beliefs, and practices, in fortifying students' investment in learning. (Wacker and Olsen, 2019)

Problem Based Learning: Problem-Based Learning (PBL) is a teaching method in which complex real-world problems are used as the vehicle to promote student learning of concepts and principles as opposed to direct presentation of facts and concepts (Capraro & Slough, 2013).

Project Based Learning: Project based learning provides a way to create more meaningful learning and promote a deeper level of understanding while also addressing constructs such as interest and value, perceived and achieved competence, and task focus (Blumenfeld et al., 1991).

Systemic Change: a paradigm shift, which requires a total, comprehensive replacement of all educational aspects (Reigeluth, 1994).

Teacher Beliefs: beliefs about teaching and learning, about instruction, about the subject, about learning to teach, and about the self (Voss- Dubberke, Kleickmann, Kunter, & Hachfeld, 2013)

Transformational Teaching: Transformational teaching is about employing strategies that promote positive changes in students' lives (Menninger, 2015).

STEM: STEM is a curriculum based on educating students in four specific disciplines in an interdisciplinary and applied approach; known simply as STEM, those subjects are Science, Technology, Engineering, and Mathematics (Hom, 2014)

Urban: The description of racial quality that is inclusive of significant minority subgroups, such as Hispanic and or Latino as well as African American students (Molina and Davis, 2002).

Organization of the Study

The first chapter, Chapter 1 will be presented as an introduction to the study as well as an overview of the background and necessity of STEM in the educational settings across the Unites States. This chapter also shares the research questions, research problem, the research purpose as well as some relevant terms to the research.

In Chapter 2, the researcher reviews relevant literature that is germane to STEM, urban education as well as curriculum related to STEM. Following that, the researcher discussed the theoretical framework, Kotter's 8 STEP Change Process, as it is implemented with STEM. Curriculum related to STEM was also discussed in Chapter 2. Also discussed was STEM professional development as well as barriers and challenges to implementation. Lastly, the importance of STEM in the U.S. Workforce and to teacher leadership.

Chapter 3 describes the methodology of this study and the way that this correlates to the research questions. Included in this chapter are the details of the research design, participant selection, instrumentation, data collection, and data analysis that will be utilized in this research.

In Chapter 4, the researcher provided a detailed analysis of the data. This chapter concludes with descriptions of common themes that emerged throughout the study as a result of collected data.

Conclusively, in Chapter 5, a summation of the research as well as a discussion of the conclusions have been shared. The major findings that were derived from the study as well as implications for the field of teacher leadership are addressed, and finally, recommendations for next steps and proposed suggestions for future research are imparted upon readers.

Conclusion

The purpose of this descriptive qualitative case study was to identify teachers' position in the process of organizational change to STEM instructional programming. The researcher utilized a qualitative case study to uncover the way to identify the successful implementation of STEM education through the lens of Kotter's 8 Step Change Model. This researcher hopes to assist other teachers in education in identifying teachers' beliefs on change and implementing STEM. Additionally, this study sought out ways to identify curricular choices in instruction for teachers that will provide students with an entry into access to STEM Education.

Chapter 2 Literature Review

The following literature review explored urban elementary school teachers' beliefs, challenges, and barriers to the organizational change necessary to implement a STEM curriculum. Subsequently, the subjects that were researched through the use of university research platforms such as Ebscohost, ProQuest, and Galileo have been identified and discussed in narrative format. Organizational change, through the lens of Kotter's 8 Step Change Process which is the theoretical framework that guides the research study. Before exploring a framework and process for change, one must understand change itself.

Change

The ability to lead change has become a valuable skill as organizations, including schools, are required to transform in order to meet higher expectations for success (Trybus, 2011). "Leaders know the sense of urgency to change and respond to the pressure to change. There is a heightened level of federal and state mandates that utilize accountability measures and the improvement of student learning as key factors to consider. Organizations shift to a new state as a result of the new interaction and ideas that are inherent to the change" (Fullan, 2004, 166). This is similar to the transformation that occurs in school as a result of change. The impetus for the study that the researcher conducted was to identify teacher's position in the change process regarding STEM instruction and identify any possible barriers for change when implementing STEM as a new curriculum. This change was observed through the lens of Kotter's Theory of Change. This theory proposes 8 steps to a full organizational change.

Systemic Change

Systemic change in education is a paradigm shift, which requires a total, comprehensive replacement of all educational aspects (Reigeluth, 1994). In a study of high-performing school systems throughout the world, researchers concluded that successful systems structured their schools to function as PLCs to provide the teacher collaboration vital to powerful professional development (Barber & Mourshed, 2009). A systemic change is often difficult to envision, let alone encourage, because people generally find it easier to focus on the parts than on the systems that connect those pieces (Connolly, 2017). According to Connolly (2017), “when we talk about systemic change in STEM education, we are referring to change in organizations and institutions” (p.1).

During a yearlong study, a team at Education Resource Strategies tried to answer the question of, “What are the gears that can turn strategic plans into powerful engines of student learning?”. They would find out by studying school systems that are gaining traction with black, Latinx, and low-income students. According to the authors, Miles and Baroody (2019) there were common threads in these school systems, the central office supported schools by: (1) setting a clear theory of action for how schools will implement the strategic priority, (2) following through with tough resource trade-offs, and (3) redesigning processes—such as timelines, tools, and mindsets—to support schools’ ability to implement the changes. Kent (2019) states that any type of major systemic change within a district or a school requires administrative support for a host of practical and logistical reasons. If teaching and learning are to improve for all students, we need change: fundamental change, affecting every aspect of our schools and every school in our school systems, change from the statehouse to the classroom. In a word, we need *systemic* change (Holzman, 1993,p.18).

Teacher Beliefs about STEM

In a study conducted by Hanegan, Pruet, Waltman, and Harlan (2015) the authors focused on identifying teacher beliefs as it relates to the implementation of the engineering design process in their classrooms. The proposed curriculum involved conducting 3 design challenges per year. The authors sought to identify what kinds of beliefs the teachers had in regards to the students. The first belief that was identified was the need to believe that the challenges were meaningful. Additionally, the teachers were asked about their knowledge levels of engineering design challenges. If the teachers believe that they have the knowledge and skills to help the outcomes, they are more likely to succeed in reaching the learning outcomes (Hanegan, Pruett, Waltman, and Harlan, 2015a). According to Hanegan et. al., (2015b) most research points out the complexity of determining the impact of teacher's beliefs and the large number of components. The study identified that teachers implemented the challenges at different rates based on their beliefs and efficacy. Research has found a consistent relation between self-efficacy and teacher beliefs and teachers' behavior in the classroom (Voet and De Wever 2019). According to Voet and De Wever (2019), there is little information about the way in which teachers' beliefs influence their implementation of Inquiry Based Learning (p.424).

According to Schoenfield, 1983 as cited in Voet and De Wever, 2019 (p.425), behavior is generally the result of beliefs about (a) the task at hand, (b)oneself, and (c)the social environment in which the task takes place. Authors Wilson and Woolfson (2018) assert that an important factor in individual teachers' beliefs about their own efficacy; are influenced by what others in their school say and do (p.30).

Kotter's Theory of Change

Kotter's Theory of Change must be understood thoroughly in order to apply it as a framework to make implementation of a STEM curriculum in an elementary school setting. There is a need for more research about the way that STEM is implemented and carried out in elementary schools. Utilizing Kotter's Theory of Change model was the crux of this study as it will lend itself to uncovering participants in various stages of the trajectory of change. Kotter, (1996) identifies an eight-stage process for producing organizational change. Since the introduction of the 8 Steps in 1996, Dr. Kotter expanded the scope of the 8-Step Process from its original version in *Leading Change* to the version outlined in his 2014 book, *Accelerate*. The purpose of Kotter's systemic process for change is outlined in his book, *8 Steps to Accelerate Change in Your Organization:* (1) Motivates people to take action. (2) Coordinates and aligns their actions. (3) Without it, strategic initiatives can struggle to get activity behind them. (4) Clarifies how the future will be different from the past, and how that future will become a reality. And (5) Ties directly to the "Big Opportunity" (Kotter, 2014). The change Kotter espouses is a systemic transformation. STEM implementation will be a systemic transformation. Systemic transformation must evolve through all eight, invariant stages in order to make sure that they do not derail the change initiative. Utilizing Kotter's (Table 1) Theory of Change was a way for the researcher to meet participants where they are and understand how they fit into the landscape of the change while leading one in the gathering of information as it relates to this study (Kotter, 2012).

The eight stages of organizational change are represented in the following table:

Table 1 Theory of Change - Kotter's 8 Step Change Process

Step	Name	Description
1 – CREATE	Sense of urgency	Help others see the need for change through a bold, aspirational opportunity statement that communicates the importance of acting immediately.
2 – BUILD	Guiding coalition	A volunteer army needs a coalition of effective people – born of its own ranks – to guide it, coordinate it, and communicate its activities.
3 – FORM	Strategic vision and initiatives	Clarify how the future will be different from the past and how you can make that future a reality through initiatives linked directly to the vision.
4 – ENLIST	Volunteer army	Large-scale change can only occur when massive numbers of people rally around a common opportunity. They must be bought-in and urgent to drive change – moving in the same direction.
5 – ENABLE	Removing barriers	Removing barriers such as inefficient processes and hierarchies provides the freedom necessary to work across silos and generate real impact.
6 – GENERATE	Short-term wins	Wins are the molecules of results. They must be recognized, collected and communicated – early and often – to track progress and energize volunteers to persist.
7 – SUSTAIN	Sustain acceleration	Press harder after the first successes. Your increasing credibility can improve systems, structures and policies. Be relentless with initiating change after change until the vision is a reality.
8 – INSTITUTE	Institute change	Articulate the connections between the new behaviors and organizational success, making sure they continue until they become strong enough to replace old habits.

Information from Kotter (2012). *Leading change.*

The steps may overlap but must be in sequence to create a compelling vision and strategy for producing lasting change (Kotter, 2014). Communication is important and Kotter recommends using every organizational vehicle for communicating the change vision. Systemic transformation must evolve through all eight, stages in order to make sure that they do not derail the change initiative (Kotter, 2014). Utilizing Kotter's (Fig.1) Theory of Change was a way for me as the researcher to meet participants where they are and understand how they fit into the landscape of the change while leading me in the gathering of information as it relates to my study (Kotter, 2012). The Theory of Change model was first proposed in Kotter's 1996 book *Leading Change*. It has been used as a standard ever since. Recently, some researchers have gathered current arguments and counter-arguments in support of the Kotter change management model (Appelbaum, Habashy, Malo, & Shafiq, 2012). Applebaum et al. reviewed each of the eight steps to examine the value and support each of the steps have, individually and collectively. In the many years since its introduction, there had been no challenges and no evidence were found against Kotter's change management model, so it remains a recommendable reference (Applebaum et al., 2012).

Kotter's Theory of Change Applied to STEM

As a result of following Kotter's eight step process, STEM teacher leaders are guided through organizational and curriculum change. Curriculum reform, that pushes instruction towards a greater focus on integrated STEM education, has a large guiding coalition in the United States. School systems have joined the guiding coalition to create change in their schools to meet the highly publicized need for a focus on STEM education (Barcelona, 2014). By following Kotter's eight step process school curriculum can become enhanced to support and encourage learning by giving rise to developing 21st century skills through STEM (Barcelona, 2014, 865). Schools must reflect on the goals, mission, and vision of implementing STEM principles constantly throughout the school year to ensure the changes are occurring and in the direction that was intended (Kotter, 2012). Because major change is so difficult to accomplish, a powerful force is required to sustain the process (Kotter, 2012, p.53). The first four steps of the theory can be looked at as unfreezing phase of the process where resistance for change is reduced. Steps five through seven are the transition phases where new behaviors, values, and attitudes are developed. The last step is related to the freezing phase where changes are reinforced in the company (Kotter, 2012).

STEM Education

STEM is a curriculum based on educating students in four specific disciplines in an interdisciplinary and applied approach; known simply as STEM, those subjects are Science, Technology, Engineering, and Mathematics (Hom, 2014). “Rather than teach the four disciplines as separate and discrete subjects, STEM integrates them into a cohesive learning paradigm based on real-world applications” (Hom, 2014, p.1).

There are interpretations of the term STEM Education that are plentiful, commonalities of the term share that an effective STEM education requires a “foundation of strong subject teaching, but also requires an interdisciplinary approach to learning that ensures young people are aware of the rich and varied opportunities that STEM study opens up for them” (Knowles, 2014, p.29). Rickman (2014) stated that Georgia has joined “45 other states and the District of Columbia in formally adopting a set of core standards for kindergarten through high school in ELA and mathematics” (p.3). According to Capraro et al. (2016), in order to achieve a successful STEM program in a diverse urban school district, it is important to provide support for problem/project based learning and professional learning communities in order to raise the achievement of the diverse student population in urban areas.

STEM Workforce

Staying competitive in today's society requires several skills in 21st century learners. Students need to possess the skills that are necessary to communicate, collaborate, utilize critical thinking skills, and be creative. These are some skills that students learn by experiencing and studying STEM topics (U.S. Department of Education, 2016).

Acknowledging that there is a shortage of skilled STEM workers and that the U.S. K-12 students are underperforming on STEM-standardized measures, the government's investments in STEM education have increased dramatically (Parker, Abel, & Denisova, 2015). Although STEM workers are at its highest level in many years, the United States is currently ranked 27th in the world for producing STEM college graduates, and U.S. students' interest and academic performance in STEM fields remain weak (Change the Equation, 2012).

The President's Council of Advisors on Science and Technology (2010) suggested that in order to face the challenge of not enough STEM workers that there are more STEM schools established. This research will inform the way in which we can increase the STEM workforce. According to Sanford (2019) STEM-related career opportunities are among the fastest-growing of all occupational clusters. The majority of these jobs will require post-secondary education, yet current projections show that the United States will fall short of demand for workers with post-secondary education by as much as 5 million by 2020.

Next Generation Science Standards

The challenge of science achievement gaps is one that scholars have struggled to solve. Recent efforts to address this vexing problem are exemplified by the conceptual shifts in the Next Generation Science Standards (NGSS, 2013). The NGSS are three dimensional in nature. The three-dimensional learning is encompassed of the science and engineering practices, crosscutting concepts, and the disciplinary core ideas, as described by the NGSS (2013). The lack of science instruction in Grades K-5 will inevitably place a major strain on achieving goals set forth in the NGSS (Isabelle, 2017). According to Meeder (2013), thousands of elementary, middle, and high schools have launched STEM programs using branded STEM curriculums such as Project Lead the Way, Engineering is Elementary, Computing Technology Industry Association of America (Comp TIA), and Intel Math. In 2003, the Engineering is Elementary (EiE, www.mos.org/eie) project was initiated to take advantage of the natural curiosity of all children to cultivate their understanding and problem-solving in engineering and technology (Cunningham, 2009).

STEM Curriculum

Problem Based Learning. Problem-based learning (PrBL) is a student-centered approach in which students learn about a subject by working in groups to solve an open-ended problem. In STEM PBL lessons, students work collaboratively to solve a real-world problem. PBL is a student-centered instructional strategy. STEM PrBL is applied to K-12 education, curriculum standards of science, technology, engineering, and math which are embedded in the project. The major purpose of STEM PrBL is to integrate all four topics (Capraro et al., 2016).

Although there was good news about student achievement in the study, the authors suggested that further research is needed to broaden the limited boundaries of the research. When implementing the STEM program, the teachers become facilitators while the students work through the problems on their own. These activities provide students with learning opportunities to become self-learners as they question, explore, and collaborate within a team. Inquiry becomes a natural part of their daily routine as they explore scientific problems that help them achieve academic success. There are both national and international studies about the use of the inquiry-based teaching method in science education. Problem based learning can be applied to STEM learning. Problem based learning is vastly different from Project based learning. Project based learning is a teaching strategy where teachers need to suggest an ill-defined task for students (Capraro & Slough, 2013). STEM PrBL is a targeted strategy and instructional method used in universities and often implemented by K-12 teachers as stated by Capraro et al. (2016). The major purpose of STEM PrBL is to integrate all four topics (Capraro et al., 2016). Many educators are familiar with STEM education. In STEM PrBL classrooms, learning should be a constructivist, collaborative, and contextual process (Clark & Ernst, 2007). STEM PBL is different than traditional instruction. STEM PrBL should be different from traditional style lecture instruction, it involves students solving a problem.

Project Based Learning. Project based learning provides a way to create more meaningful learning and promote a deeper level of understanding while also addressing constructs such as interest and value, perceived and achieved competence, and task focus (Blumenfeld et al., 1991). The ill-defined task has been shown to stimulate inquiry learning which has proven to be more effective than typical well-defined classroom instruction (Mills & Kim, 2017). These educators set out to teach problem skills when the task was ill-defined:

In the real world, students encounter problems that are complex, not well defined, and lack a clear solution and approach. They need to be able to identify and apply different strategies to solve these problems. However, problem solving skills do not necessarily develop naturally; they need to be explicitly taught in a way that can be transferred across multiple settings and contexts (Mills & Kim, 2017, p.2).

In a study conducted by Capraro et al. (2016), there is a perception that including students in STEM PBL will positively affect high need students in the study. The study focused on two identified groups, Hispanic students and high need students who were identified by math scores.

The sample consisted of 528 students in three PBL schools and 2,688 students in Non-STEM PBL schools in the same region. The study was grounded in hypotheses based on other studies that the STEM PBL would have positive impact on both the Hispanic students as well as the at-risk students (Capraro et al., 2016). There is also a question on the effectiveness of STEM PBL engagement which presents an additional gap. There are not enough studies that have addressed the academic component of PBL effectiveness (Capraro et al., 2016). The results of this study are that there were latent growth models utilized and it was found that the students showed increased mathematics achievement as a result of receiving STEM PBL instruction.

In another study conducted by Hall and Miro (2016) which set out to identify how PBL was implemented in a variety of educational settings and which processes impact student learning and engagement. The data collection method employed in this study was the use of observation of the occurrence of PBL in the classroom. The instructional strategies that were being identified with most interest in this study were teachers as facilitators, higher level questioning strategies; hands on or experiential learning; student responsibility for learning; active learning; student research; student centeredness; small group collaboration; assessment and feedback; and STEM integration (Blumenfeld et al., 1991; Bruce-Davis et al., 2012; Walker & Leary, 2009; Walton, 2014). The findings were that the examination of beliefs or attitudes of teachers to examine their impact on implementing PBL. Comprehensively, PBL has been identified as an effective strategy for STEM PBL.

Curriculum Revision. In a study conducted by Parker, McKinney, Smith, and Laurier (2016), there was a focus on the curricular revision utilizing the Engineering Design Process in a

STEM focused school. The engineering design process is a cyclical process that guides engineers through solving problems (Teach Engineering, 2015). In this study the process of revising the curriculum is an iterative process. The project focused on STEM Achievement in Baltimore Elementary Schools (SABES). SABES main focus is to implement in school STEM curriculum, teacher professional development, an afterschool program, and community events. Parker et al. (2016) research study is focused on STEM-based curricular improvements. The idea of integrating curriculum should is not just for engineers, scientists, or school laboratories. Students must be able to transfer all learning across curricular areas and make connections that can increase levels of academic achievement (Barcelona, 2014).

Types of STEM Curriculum Implemented

The following curriculums have been utilized by the researcher in a school setting. The researcher provides a brief description of each curricular option. Project Lead the Way is a curriculum that is available for K-12 educational settings. The 5E lesson cycle is an inquiry-based curriculum that can be used in the K-12 classroom. Engineering is Elementary is a K-5 curriculum that is based on the engineering design process has been utilized in elementary schools. Each of these curricula can support the needs of schools with STEM implementation depending on what they are looking for.

Project Lead the Way. In a study conducted by Stohlmann, Moore, and Roehrig 2012, the ultimate goal was to identify ways to teach STEM education and what were the main factors that affected the implementation of Project Lead the Way (PLTW) curriculum. Stohlmann et al. (2012) found that a focus on connections, representations, and misconceptions can aid in the pedagogy in a STEM classroom. The use of integrated STEM activities in a classroom allow teachers to focus on big ideas that are interrelated. In the study, suggested ways to approach student knowledge was listed such as: build on student's prior knowledge, organize knowledge around big ideas, concepts or themes, develop student knowledge to interrelate concepts and processes. The teachers in the study implemented Project Lead the Way Units. Each teacher had a different subject area background. In eleven of the twelve classrooms there was a student-centered approach utilized, this was inclusive of having the students to work together and develop their own ideas. The authors of this study identified the importance of teachers allowing students to lead the learning in STEM and the importance of them acting as facilitators and not leading the learning. Effective STEM education is vital for the future success of students. The preparation and support of teachers of integrated STEM education is essential for achieving these goals (Stohlmann et al., 2012). According to Thomas (2014) in order to address quality pedagogical practice through curriculum development, Project Lead the Way (PLTW) and Engineering is Elementary (EIE), along with other innovators, have stepped up to try to fill the demand for teaching using the 5 E Instructional Model.

Engineering is Elementary. Engineering is elementary (EIE) is a curriculum that was created by Boston University. The EIE curriculum is based on the social constructivist view of learning (www.eie.org). The structure of engineering is elementary is to have students to work on engineering design challenges that show students how what they learn connects to the world around them. In looking at the EIE curricula, the 4 C's of 21st century learning is apparent. The curricula include collaboration, communication, critical thinking, and creativity. Research suggests that engineering activities help build classroom equity (www.eie.org). According to the designers of engineering is elementary, the engineering design process removes the stigma from failure; instead, failure is an important part of the problem-solving process and a positive way to learn.

5 E Learning Cycle. The 5E model of science instruction does not use any specific set of material resources, it uses inquiry as a framework (Chitman-Booker & Kopp, 2013). The 5E model promotes scientific literacy. Collectively, all the facts and information, along with the understanding of the nature of science, the scientific enterprise and the role of science in society and personal life make up scientific literacy (National Science Education Standards, 1996). On the authority of Chitman-Booker and Kopp (2013), the 5E model engages student's thinking, then allows for explorative discovery and factual learning to deepen students' understanding of content.

Cahyarini, Rahayu, and Yahmin (2016) investigated the effect of the 5E learning cycle. Based on the study, the statistics showed a significant difference in students' critical thinking in the students who were taught by using the conventional method. The authors reported that there were no significant differences in students' thinking when they were taught using the 5E lesson cycle and socioscientific issues (LC+SSI) model and students who were taught using 5E LC model. The authors believe that critical thinking is an important thinking skill for students to develop. They also believe that critical thinking can be used throughout their adult life in education, work, and interpersonal relationships.

Cahyarini et al., (2016) suggested that many teachers agree that thinking skills can be taught indirectly through various learning experiences. The study showed that Socioscientific issues (SSI) are an issue that is related to social issues that occur in today's society. It covers concepts in technology and the relationship to science. According to Cahyarini et al., (2016) based on the results of their findings, the 5E learning cycle including SocioScientific issues instructional model can affect the students' critical thinking in acid –base material. They also concluded that the model gives a better effect on how students develop their critical thinking skills. The BSCS 5E Instructional Model can be used as the basis for instructional materials that align with the aims of Next Generation Science Standards (Bybee, 2015).

STEM in Elementary Schools

Although there are no designated STEM standards, much has been done to improve curricular standards in various STEM content areas. Promoting science, technology, engineering, and mathematics (STEM) in public education is commonly viewed as a key strategy in maintaining America’s competitiveness in the rapidly changing and increasingly global 21st Century economy (Hansen, 2014). Students in STEM schools would show higher outcomes on key measures relative to students in non-STEM schools (Hansen, 2014). A strong school improvement structure, grounded in research-based practices, provides the foundation upon which to implement a high-quality STEM program (Meeder, 2013).

The Early Childhood and Education profession typically values integration across content areas, which “Promotes learning through exploration” according to Linder, Emerson, Hefron, Shevlin, and Vest (2016). The exploration is often referred to as the process of inquiry, which encourages students to learn through exploration and asking questions.

According to Linder et al., (2016), “This method is highly productive; however, hinges on the ability of educators to harness this process and incorporate STEM education into their classrooms on a consistent and effective basis. According to Kotter (2012), empower others to act on the vision. “The three profiles in the article wrestle with creative integration, centralizing STEM focus in the classroom, and refining STEM in the classroom. These issues are able to be conquered with the exertion of educators who value STEM education. These methods include, but are not limited to: find problems for students to solve, incorporate student interest into the classroom, build literary connections, and highlighting student learning processes.

The findings of this article are most substantial in its focus on STEM instructional programming being implemented in the elementary classroom and the willingness of educators to modify techniques based on the needs of students. The modifications are student driven. Educators must have to ability to assess preparation and proceed accordingly.

This may be comprised of researching methods of incorporation, engaging with students to learn their interests, and centralizing the focus of STEM versus teaching it on teaching methods. The purpose of STEM is to encourage meaningful learning experiences for students (Linder & Emerson, 2016). STEM influences learning, motivation, and levels of engagement. Thus, the most powerful tool is educational programming.

STEM in Urban Elementary Schools

Some researchers may believe that elementary students are not too young to participate in and understand STEM education concepts (Brenner, 2009; Bybee & Fuchs, 2006; Walker et. al., 2012). However, current research studies are investigating the importance of STEM instruction in Elementary schools in particular urban Elementary educational settings.

Why is STEM important to Elementary School Settings?

It is argued that the elementary grade levels are the best time to stimulate interest in, connections to, and motivation for the STEM fields (McClure et al., 2017). DeJarnette (2012) suggests that one way to address STEM involvement in the elementary school setting is to improve working relationships between higher education and elementary education to shift pedagogical practices to allow more student inquiry and problem-based learning. Students who were exposed to integrated approaches demonstrated greater achievement in STEM subjects (Barcelona, 2014). In the elementary grades, students apply the rigor of science, technology, engineering, and mathematics content and the STEM Standards of Practice while engaged in learning activities that investigate the natural world (MDK12, 2019). Engineering is a new subject for most elementary school teachers, and so far, only a few states (e.g., Massachusetts and Minnesota) have developed educational learning standards that include engineering at the elementary level (Cunningham, 2009). Elementary science is a critical part of the K–12 science education system (Keeley, 2017). There are a few studies that have begun investigating the importance of STEM in urban Elementary schools. These studies have revealed that professional development, teacher knowledge and support and critical to urban STEM Elementary implementation. In one STEM school, the LEAP Program industry professionals have been hired to teach classes (Bonilla-Santiago, 2011). An integrated approach at the elementary level is supported by recent research. Cotabish, Dailey, Robinson, and Hughes (2013) found that elementary-aged, general education students of teachers who employed rigorous curriculum and inquiry-based instruction supported by intensive professional development showed statistically significant gains in science process skills, science concepts, and science-content knowledge when compared with students in a comparison group.

Supports for STEM Implementation

According to the U.S. Department of Education (2007), 75% of the fastest growing occupations require significant science or mathematics training fastest growing occupations require significant science or mathematics training. Students who were exposed to integrative approaches demonstrated greater achievement in STEM subjects. Successful STEM implementation according to a study of Bennett Woods Elementary School looks different than the traditional teacher-led classroom (Meeder, 2013). A prime goal of STEM educational reform is to encourage a shift from teacher centered classrooms where students are passive consumers to student-centered environments where learning is an active process (Smith, Vinson, Smith, Lewin, & Stetzer, 2014). According to Myers and Berkowicz (2015, p.8).

The STEM shift encourages reimagining schools from kindergarten through 12th grade, including the way curriculum is designed, organized, and delivered. Blackley and Howell (2015) state that the move towards integrated STEM education and the emerging pedagogical frameworks is a step closer to achieving STEM in schools. In an effort to support STEM education, Every Student Succeeds Act allows states the flexibility to set new policy and funding priorities (Peterson, 2017). According to Peterson (2017), STEM learning opportunities and support for STEM teachers are mentioned specifically throughout the ESSA.

Challenges and Barriers to STEM Implementation

According to Isabelle (2017) “one challenge faced by elementary educators is that they work in an environment of high stakes testing for English language arts and mathematics (p.89).” Additionally, a challenge that is faced by elementary teachers is administrators supporting equity in science instructional time, purchasing science materials, and offering multiple professional development opportunities (Isabelle, 2017 p.89). According to Shernoff, Sinha, Bressler, and Ginsberg (2017), there is a growing need to integrate approaches to STEM in the field of education although there are many challenges when developing and implementing the STEM curricula. The barriers to STEM education present itself in several forms. Teachers with negative attitudes toward STEM tend to avoid teaching STEM (Appleton, 2013). Far too many students are blocked from opportunities to master STEM because of false assumptions about aptitude (Drew, 2013). Obstacles may include a lack of needed skills, structures that make it difficult for faculty and staff to act, lack of alignment of support systems with the vision and individuals that are undercutting the reform efforts (Farris, Demb, Janke, Kelley, & Scott, (2017). Nadelson, Callahan, Pyke, Matthew, and Pfiester (2013) observed that, “Student foundational knowledge of science, technology, engineering, and mathematics (STEM) is formed in their elementary education. Paradoxically, many elementary teachers have constrained background knowledge, confidence, and efficacy for teaching STEM that may hamper student STEM learning” (p.157).

The literature poses some challenges to implementation based on the lack of skills, absence of vision and not enough alignment with supports just to name a few. In integrated programs, teachers find themselves forced to learn new content, material that likely does not come easy to them (Rush, 2011). Some teachers are focusing on the traditional teaching of science and mathematics and virtually ignoring the technology and engineering components (Moore & Smith, 2014).

STEM implementation has a great deal of barriers as stated above. After looking in further detail, there are two additional barriers noted in a recent article. According to Blackley and Howell (2015), two keys reasons for lack of success in STEM Education is (1) the curriculum structure and (2) skill level and or preparation for the teacher. Blackley and Howell (2015) propose that the curriculum structure and the skill level and preparation for the teacher are the main factors that STEM initiatives have failed. As a result of these findings, more research seems to be needed in relation to professional development and STEM education.

STEM Professional Development

Research around professional development says that it must be meaningful to the adult who is participating in the learning. According to Darling-Hammond, Hyler, and Gardner (2017), effective professional development structures professional learning that is content focused. Professional development that incorporates active learning is directly related to trying out teaching strategies such as a focus on curriculum development in pedagogies in mathematics, science, or literacy (Darling-Hammond, Hyler & Gardner, 2017).

Darling-Hammond, et al., (2017) also suggested that effective professional development creates a collaborative space for teachers to have job-embedded collaborative contexts. In addition to the aforementioned, effective professional development has coaching and support linked to evidence-based practices. Merriam (2001) outlined five underlying andragogy describing the adult learner as some who: (1) have an independent self-concept, (2) can direct their own learning, (3) have accumulated a reservoir of life experiences, (4) have learning needs close, (5) are problem-centered and interested in immediate application of the learning, and (6) are motivated to learn internally.

According to Knowles (1984), there are 4 assumptions of adult learners that are different from child learners. The four assumptions are self-concept, adult learner experience, readiness to learn, and their orientation to learning. Professional development in STEM should focus on enhancing content knowledge because targeted and specific professional learning has the potential to positively impact teacher practice (Nadelson & Finnegan, 2014). Professional development is important to STEM education, especially in the areas of technology and engineering (Avery & Reeve, 2013). Avery and Reeve (2013) suggest that a need exists to examine factors that can contribute to successful professional development in the STEM areas as it concerns integrating engineering design into core academic subjects. It is unlikely that without considerable continuing education, K-5 teachers can be prepared to teach effectively STEM curriculum around themes (NSTA, 2002). Being able to support teachers and provide them with professional development that is going to be STEM focused and job-embedded is a must for teachers who will be teaching STEM curriculum.

Sustained Professional Development

Professional development in the STEM areas is essential to addressing deficiencies in content and curriculum knowledge and, therefore, should be ongoing and occur at multiple stages in teachers' careers (Loucks-Horsley, Hewson, Love & Stiles, 2010). The researchers investigated two phases of a needs assessment to identify the challenges that teachers are facing today. The participants were asked to identify the challenges and support that they would need to successfully implement STEM in the school districts on the East Coast of the United States. The participants then attended a variety of STEM conceptualization trainings, which was based on the Department of Education's definition of STEM. There were 22 teachers in grades K-12 who answered open-ended questions that were qualitatively coded. The recipients participated in a 5-day academy that was led by master teachers and district level leadership. Data collection was conducted through a semi structured interview which varied in collection lengths. The study found that the teachers declared a need for certain skills to allow them to obtain a greater level of knowledge as it relates to STEM instruction.

This particular study established the urgency of the need for developing and integrating sustained STEM professional development. This study establishes the need for more studies to be conducted on the topic of STEM-based professional development and its effect on STEM implementation. According to the team of Capraro et al., (2016), there is a great impact of sustained professional development that can support STEM on outcome measures in diverse urban schools. STEM promotes project-based learning, develops professional learning and increases student achievement. Kotter's Theory (2012), stage six suggests that sustaining change efforts requires compelling evidence of progress within 12-24 months. So, as student achievement increases, short term wins must be actively demonstrated through clear performance improvements. The authors' study revealed data which showed students who experienced project-based learning experiences with the greatest fidelity of implementation, showed significant gains on standardized tests. The study also revealed the students with the lowest fidelity of implementation by teachers had negative academic gains. The data indicated when teacher perception of the STEM program was high and they welcomed the benefits from the implementation of project-based learning, there were greater results. According to Guskey and Yoon (2009), there are several characteristics of an effective professional development which were identified in the study which includes three structural features: reform type, duration of professional development, and collective participation; and three core features: opportunities for active learning, coherence, and content focus. The authors found that the most effective of the features is intensive and sustained professional development. According to Borko (2004); Bredeson (2002); and Fullan (2008), not all professional development is effective, particularly, when it is unfocused, disconnected from the realities of the classroom, imposed top down, ignores adult learning preferences, lacks intellectual challenge and when it follows a pre-packaged one size fits all formula as cited in Gibson and Brooks' (2013) study. In Gibson and Brooks' (2013) study, the teachers went through a year-long series of professional development at the district level. Despite the national movement for K-12 STEM education and its corresponding push to develop STEM educators, comparatively little attention had been given to the content of STEM teacher preparation or professional development (Rinke, Gladstone-Brown, Kinlaw, & Cappiello, 2016).

Short Term Professional Development

Guskey (1986, 2000) has claimed that most of the professional development programs for teachers have been based on a deficit paradigm. To make the most of any PD experience, teachers have to be clear about the change they seek, align their PD engagement accordingly, and make concrete plans for implementation, West (2019). The capacity to think deeply about one's practice is critical to identifying areas of needed change. Since no single PD event will solve every issue facing a teacher, it is important to be strategic. Once the conference concludes, teachers should draft an implementation plan.

One strategy is to team up with a fellow conference attendee, or a larger group of attendees, to discuss the successes and setbacks of change. West also shares, "One of the benefits of attending conferences is the interaction with like-minded colleagues" (2019). In this perspective, conferences are short term professional development.

In a study conducted in conjunction with the National Center for Research on Evaluation, the study had participants volunteer to join a short term professional development pilot. According to Buschang (2012), results from this study suggest that both short-term professional development sessions were well received by teachers. Evidence from this study also suggested that there was an impact of the experimental professional development session on specific aspects of teacher knowledge and skill related to evaluating student work in less than one full day (Buschang, 2012, p.51). The literature recommends that effective professional development should (a) focus on a limited number of teaching practices, (b) address a specific content area, (c) provide opportunities for "active" learning, and (d) persist over time to increase the likelihood of positive outcomes (Buschang, 2012).

The conclusions by Garet et al. (2001) suggest that if teacher professional development programs are focused on providing active learning opportunities, shorter term programs may also impact teacher outcomes.

Content Knowledge

According to Bonilla-Santiago (2014), teachers lack knowledge in the content needed to teach the STEM areas effectively. The effective teaching of STEM content in the elementary curriculum moves beyond assuring an informed citizenry; it is also crucial for meeting the tremendous demand for STEM professionals (Nadelson & Finnegan, 2014). Elementary student reliance on teachers for the acquisition of accurate STEM content and development of foundational STEM knowledge provides motivation for assuring elementary teachers are provided opportunities to continue their development of STEM understanding (NRC, 2011).Researches revealed that qualified teachers were essential to STEM teaching and professional development was necessary to cultivate content knowledge as well as pedagogical knowledge is a current challenge in most of developing countries (Polamalu and Huang, 2017). In a report given to President Obama PCAST (2010, p.77) explained that great STEM has at least two attributes: deep content knowledge in STEM and strong pedagogical skills for teaching their students STEM. Wimsatt (2012) found a statistically significant relationship between a science teacher's content knowledge and self-efficacy in teaching science.

STEM Teacher Leadership

Teacher leadership in particular holds great promise for schools wishing to close the achievement gaps, as it has been contended that teacher leaders have the capacity to lead the school via increasing teacher collaboration, spreading best practices, offering assistance with differentiation, and focusing on content specific issues (Curtis, 2013). Working in collaboration with school building leaders and fellow teachers, STEM teacher leaders can assess needs, plan, and build support for STEM instruction as a school-wide priority (innovation.ed.gov). According to Wenner (2017), it appears that science teacher leaders would benefit from more targeted training and evaluation measures and a science teacher leader network. STEM can become integrated into elementary classrooms when teacher leaders are ready to provide guidance, support, and coaching (Barrett-Zahn, 2019).

STEM Teacher Leader's Role in Leading Change

Wenner (2017) outlined seven dimensions of practice for science teacher leaders (STLs) in a study. This study looked to York-Barr and Duke (2004) and their seminal literature review on teacher leadership to frame perspectives concerning science teacher leadership. In particular, this study sought to uncover what STLs do, what conditions influence STLs, and what might be done to increase the effectiveness of STLs. The seven dimensions were coordination and management, school and district curriculum work, professional development of colleagues, participation in school change, parent and community involvement, contributions to the profession, and preservice teacher education. Wenner (2017) shares that science teacher leaders have the capacity to lead change, this was based on STL's leading an entire K-8 school into a specific curriculum and or program (p.123). One such role in change is to participate in schoolwide decision making. In this study, Wenner provides the teacher leader dimensions of practice in a study that was focused on identifying how to close the achievement gap in urban schools. This is important because the STEM Teacher Leader is a role that is needed to build, promote, and encourage STEM.

Luft, Dubois, Kaufmann and Plank (2016) lean on Rhoton's theory of a teacher leader impacting the public, policy makers, and the educational field. The Teacher Leader may also be the facilitator of organizational change and STEM instruction. There is a need for additional research on the topic of how to provide these leaders with assistance in leading the organizational and curricular change. Leadership needs to find a shared understanding of what defines STEM education (Meeder, 2013). Teacher leaders, according to Gillespie (2015), are teachers who take responsibility for their own professional learning and support their peers through collaborative networks can transform teaching and learning within their buildings, districts, and beyond.

After review of the literature, limited research is available for Teacher Leaders to help support urban elementary teachers when curriculum and organizational change occurs. Additional research is needed to help Teacher Leaders understand the process of change in an elementary urban school environment with STEM education is being implemented. The researcher utilized Kotter's Theory as a guiding framework in the investigation.

Chapter 3: Methodology

Research Purpose and Questions

The purpose of this exploratory case study was to examine teacher and leader resistance to change in instructional programming during their beginning stages of STEM implementation at an urban elementary school in a large city. Primarily, this study sought out to examine the perceptions and causes of the resistance to changes to instructional programming to STEM by teachers and leaders in the implementation of STEM programming. The goal of STEM education is to use the constructivist method to provide and build content understandings and application of knowledge (Chaille & Davis, 2015).

This thinking also includes the use of the 21st Century skills known as the 4 C's; they are collaboration, communication, creativity, and critical thinking. To be effective in classrooms of today, elementary teachers will need to expand their treatment of the content from an array of STEM disciplines and embrace T-shaped dispositions (creativity, teamwork, innovation, problem-based learning) and ultimately, pass these characteristics on to their students (Chaille & Davis, 2015).

As a research endeavor, the case study contributes uniquely to our knowledge of individual, organizational, social, and political phenomena (Yin, 2009). In all of these situations, the distinctive need for case studies arise out of the desire to understand complex social phenomena (Yin, 2009).

Yin, Merriam, and Stake are three seminal authors who provide procedures to follow when conducting case study research which aid educational researchers to construct a roadmap in their utilization of case study (Yazan, 2015).

In order to conduct this study, the researcher decided to use a qualitative approach for a myriad of reasons. The use of an exploratory case study based on the work of Yin (2009) was chosen as it provided insight into the how and why of this phenomenon. One of the primary reasons that a qualitative approach was chosen is because it allowed the researcher to study a phenomenon that was occurring in real life. An exploratory case study design explores without manipulation. Its main goal is to identify mechanisms of why things happen and the reason for choices (Yin, 2009).

Research Questions

The questioning structure that guided this qualitative exploratory case study was the format of two questions. This research was conducted in an elementary school in an urban city. The utilization of these questions aided in the exploration of the resistance to change in instructional programming by the teachers and leaders of this particular urban elementary school.

Research Question 1:

How does Kotter's model impact teacher's implementation of STEM?

Research Question 2:

What are the supports, challenges, and barriers to STEM implementation in an elementary school setting?

Case Study Research Methodology

According to Yin (2009), an exploratory case study method represents the qualitative research design for providing an explanation to provide the main reasons or factors that teachers and leaders are resistant to change their instructional programming. Qualitative research allows for the study of research problems for individuals and groups within the natural setting of a research problem in order to identify the possible themes or patterns that may emerge (Creswell, 2014). The research method that was employed was a qualitative method research design to research, implement, and write the report of findings for this dissertation. According to Creswell (Creswell, 2014) the case study method is a widely-accepted method where the researcher develops an in-depth analysis of a case, often a program, event activity, process, or one or more individuals. The researcher looked at a specific urban school working towards implementing a change to STEM instructional programming and how the school teachers perceive this change and placed them on Kotter's 8 Step Change Model. Using this type of research method can provide, rich, descriptive data of lived experiences that can be used to transform the setting (Creswell, 2014).

The case study is a form of methodology that will afford for the researcher to investigate teachers' perception to a change to STEM instructional programming. A case study is the study of a particularity and complexity of a single case, coming to understand its activity within important circumstances (Stake, 2010). The choice of conducting research at this school is important because the researcher has personal and professional interests in the found outcomes. The researcher viewed this case study through a transformative, change oriented lens. This transformative lens that surrounded the case study which will be bounded by time and activity. A variety of data collection occurred over a specified period of time (Stake, 2010).

The theory behind the transformative worldview is that there is some type of oppression, which in this case are the minority students who are not receiving the best science instruction based on the teacher's resistance to a change to STEM instructional programming. A case study aims to build understanding by addressing research questions and triangulating descriptions with interpretations (Biber 2017).

Figure 1. Comparison Chart of Research -Comparing Yin, Stake, Merriam

Definitions of a Case Study

	Robert Yin	**Robert Stake**	**Sharan Merriam**
Method for Case Study	Qualitative and Quantitative	Qualitative	Qualitative
Data Gathering	multiple sources	multiple sources	multiple sources
Tools to gather data	combination of quantitative and qualitative evidentiary sources	exclusive use of qualitative data	exclusive use of qualitative data
Case study method	. Well-structured. comprised of five components: a study's questions; its propositions, if any; its unit(s) of analysis; the logic linking the data to the propositions; and the criteria interpreting the findings.	Structured but flexible. allowing researchers to make major changes even after they proceed from design to research	Combination Yin and Stake approaches. Designing qualitative research in a rather detailed fashion
Data gathering	Case study detail design should precede the data collection. The collection procedure is "Not routinized" (Yin, 2002, p. 58).	Does not mention any sampling strategies or procedures for qualitative case study research	Purposive or purposeful sampling usually occurs before the data are gathered, whereas theoretical sampling is done in conjunction with data collection" (Merriam, 1998, p. 66).
Steps to approach the research	Comprised of five components: a study's questions; its propositions, if any;	Obvious flexibility. This notion builds upon the assumption that "the course of the	Includes conducting literature review, constructing a theoretical framework, identify a

Definitions of a Case Study

	Robert Yin	**Robert Stake**	**Sharan Merriam**
	its unit(s) of analysis; the logic linking the data to the propositions; and the criteria to interpret the findings.	study cannot be charted in advance" (Stake, 2010, p. 22),	research problem, crafting and sharpening research questions, and selecting the sample
Data Collection Plans	Pilot study recommended as it will help refine "data collection plans with respect to both the content of the data and the procedures to be followed" (Yin, 2002, p. 79). Avoids major modifications	Stake (2010) argues "There is no particular moment when data collection begins" (p. 49) since data collection can lead to some fundamental alterations in the inquiry process	Flexible. "Purposive or purposeful sampling usually occurs before the data are gathered, whereas theoretical sampling is done in conjunction with data collection" (Merriam, 1998, p. 66).
Analyzing Data	Yin addresses his criteria for quality research, namely validity and reliability, while discussing the analytic procedures in case study. All the techniques and strategies he suggests are conducive to enhancing validity and reliability during analysis.	Stake describes two strategic ways to analyze data: Categorical Aggregation and Direct Interpretation, which he presents as two general strategies to handle case study data. "Each researcher needs, through experience and reflection, to find the forms of analysis that work for him or her" (Stake, 2010, p. 77).	Defines data analysis as "the process of making sense out of the data. Involves consolidating, reducing, and interpreting what people have said and what the researcher has seen and read – it is the process of making meaning" (Merriam, 1998, p. 178). Advocates for a recursive and dynamic data collection and analysis.

Research Setting and Participants

The context of this study was the elementary school where the researcher works on a daily basis. This elementary school is located in an urban school district. The targeted group of participants for the study was classroom teachers, STEM teachers, and one instructional coach. Merriam (2009) stated that the participant sample should be enough to answer the research question; although no particular number was stated. The school is an urban school that serves minority students. The school is a Title I school that receives 100% free and reduced lunch and breakfast based on the poverty level of the community. The school is comprised of a student population that is 97% African American and 3% White or other which encompasses all of the student body. The researcher utilized purposive sampling in selecting the participants for the case study. Creswell (2015, p.205) states that purposeful sampling applies to both people and places. Additionally, the strategy of theory or content sampling is a strategy within purposeful sampling in which the researcher samples individuals or sites because they can help the researcher generate or discover a specific context within the theory (Creswell, 2015 p.207).The strategy was to conduct a theory or concept sampling of the stakeholders in the school for the case study will assist in uncovering the reason or reasons for the resistance to change in this urban elementary school.

The research design that was chosen is a single case study in relation to the phenomenon that is occurring, which is the change to STEM instructional programming. This methodology was chosen because the study participants have a stake in the topic as well. The instructional coach serves all grade levels and is the reason that one of the participant roles was selected to provide a more school-wide lens on the study. Teachers know what is occurring in their classroom and may not have as much knowledge on the school-wide occurrences as the instructional coach and other teachers without a homeroom class.

The case study will be bounded by time and place, which is in the school setting during school operating hours. In accordance with the Institutional Review Board (IRB), the researcher began to conduct this study once approval was received.

The processes and procedures that were followed were the ones that have been established for research that involves humans as subjects. In order to select the participants, the researcher used a convenience sample from the staff. Participants then signed consent forms that stated they are in complete understanding of the reason for the research, how much time will be required, and the perceived risks associated with the research and benefits if any. In order to maintain confidentiality, the participants utilized a pseudonym in order to abstain from any information that will lead to their being identifiable. The study observed how teachers reacted to the change in their mandated instructional programming and to observe if they made any changes or transformation or maintained their current instructional practices and programming. The eight participants will be linked to their data through the use of a pseudonym.

Sampling Procedures

In order to select the participants, we used a convenience sample from the staff. Coupling this with willing participants generated the desired number of research participants. The participants signed consent forms that stated they were in complete understanding of the reason for the research, how much time will be required, and the perceived risks associated with the research and benefits if any. Additionally, the strategy of theory or content sampling is a strategy within purposeful sampling in which the researcher samples individuals or sites because they can help the researcher generate or discover a specific context within the theory (Creswell, 2015). The strategy was to conduct a theory or concept sampling of the stakeholders in the school for the case study will assist in uncovering the reason or reasons for the resistance to change in this urban elementary school.

In order to maintain confidentiality, the participants utilized a pseudonym in order to abstain from any information being singularly identifiable to any participant. The study observed how teachers react to the change in their mandated instructional programming and observed if they made any instructional changes or transformation or maintain their current instructional practices and programming.

Positionality

As a researcher, my lens was focused on the reasons for the resistance to change in instructional programming. My worldview as a researcher is that of a transformative leader. As a researcher, I am on the outside of the group looking through the lens of a transformational leader. Positionality represents a space in which objectivism and subjectivism meet. This objectivism encompassed my assortment of roles in this research case. There is a perceived release of understanding by the teachers that in the position of Instructional Coach and teacher leader that the researcher does not understand their daily instructional delivery struggle, which then posits me as an outsider. The power relationship embedded in the interview context is culturally constructed and hence subject to the influences of gender, educational background, and seniority (Merriam, Johnson-Bailey, Lee, Lee, Ntseane, & Muhamad, 2001, p. 412). The researcher is situated in a myriad of roles such as coach, teacher leader, colleague, African American woman, STEM Program Specialist, observer and researcher. As Freire suggests, the two exist is a “dialectic relationship” (Freire, 2000, p. 50). As an insider and outsider in this research my positionality in relation to this study is interwoven in an inside and outside position.

As a researcher of this group of participants, they were viewed in the position of an outsider. Positionality requires that both acknowledgment and allowance is made by the researcher to locate their views, values, and beliefs in relation to the research process and the research output (Holmes, 2014). One of my insider views is that of an educator and a colleague to the research participants. This is also oppositional to the position that I have as the Instructional Coach. It is a perceived position of power over them. “Positionality is thus determined by where one stands in relation to ‘the other’” (Merriam, et. al, 2001, p. 411). In addition to this perceived power, there is also an apparent perception of greater knowledge of the STEM integration and implementation capabilities. It is reasonable to expect that the researcher’s beliefs, political stance, cultural background (gender, race, class, socioeconomic status, educational background) are important variables that may affect the research process (Bourke, 2014).

Data Generation Sources

Data was gathered primarily through the use of observations (7), interviews (5), and focus group (pre- study and post- study). Appendix A is composed of both instruments that will be used. One instrument will be created by the researcher. The other classroom observation tool that was utilized was the Teaching Dimensions Observation Protocol (TDOP), with permissions from the University; which is cited. I utilized this observation instrument to ensure that observations are intentional, consistent, and relate back to the research question and topics. The semi-structured instrument Appendix B was comprised of open-ended questions to allow the participants to provide information without limitations.

This instrument also utilized a likert Scale in order to quantify the responses. The researcher also interviewed the participants individually in a setting and at a time of their choice that utilized open ended questions and which is included in Appendix B. These interviews were conducted on a one on one basis, and with permission were also recorded to capture the audio for accuracy. I encouraged participants to keep a journal on how they felt when they begin with these new programming so that there is data to identify their actions towards implementing change or remaining the same in their instructional practices. This will be an additional data source to support the reflective piece at the end of the research period. The questions addressed their perceptions of change, how they felt about implementing STEM programming in an urban school, and how they felt about change. Data gathering included a variety of documents and artifacts such as field notes, STEM continuum, photos, and lesson planning documents.

Lastly, the researcher conducted two focus groups, one pre-study and the other post-study and invited all participants to come and contribute to the focus group so that more data can be generated to provide a whole picture of what was observed. These interviews ensured that there was a variety in the sampling of the whole case at large. Additionally, the group dynamic provided a different lens in which to examine the group.

Data Analysis

In order to analyze all of the data that was collected, the data artifacts will be used in order to generate graphics and identify codes and families of codes. The researcher employed the use of the computer analysis program Atlas.ti, which is a computer aided qualitative data analysis program. The data from the observations, focus groups, and interviews were triangulated. The other data such as the photos and audio notes were also coded. The information collected during the interviews were transcribed and then the researcher coded it according to its contents. Open coding was bestowed upon the data to identify common themes that emerged from the interviews. Some of the coding categories that emerged were those such as teacher perceptions, change, support, and professional development.

The coding focused on apparent themes and issues that arose in conversations, interviews, observations, and notes. Coding was also be categorized by theoretical frameworks, perceptions, and or emotional attributes. All of this information assisted in providing a clear picture that resulted in written narrative form, graphic form such as a network tree, and other visual forms such as co-occurrences.

Confidentiality and Ethics

The researcher will not make the participants feel that they are obligated to participate in the research. As the researcher, all of the possible effects of the study were outlined. The researcher was very specific about research timelines, and stayed true to the best of my ability to what I told the participants. In addition, as the researcher, I made it a point to be minimally intrusive to the participants. Thus, the researcher ensured that the participant's information maintained protected and private. The researcher removed any identifying information from my records (Lichtman, 2011). In an effort to maintain a positive environment during the research I anticipated and prevented any ethical dilemmas that may have arisen. Building a professional rapport with participants, and providing them with a trustworthy environment allowed participants to be open and honest about their experiences (Lichtman, 2011). Research data should be collected, reported, and shared in an accurate manner. As a researcher, I avoided inflicting my personal beliefs and biases on the participants of the research study. In order to conduct research, approval was obtained prior to beginning the actual research study. The approval was obtained from an IRB or institutional review board. This board approves, monitors, and reviews research through approved protocols.

Trustworthiness

There is a set of constructs that have been created by Guba and Lincoln (2005) that also have been employed by the positivist investigator and they are credibility, transferability, dependability, and confirmability (Shenton, 2004.) Credibility deals with identifying the findings and their congruence with reality. In order for me to identify the credibility in my study, I triangulated the data from the focus groups, interviews, and the surveys by interviewing the teachers, STEM Specialists, and the Instructional Coaches. I also shared my personal beliefs about the integration and implementation of STEM into classroom instruction. Another way to do this was by maintaining a reflective journal as the researcher to ensure trustworthiness. This provided additional data not to persuade. Also, the researcher encouraged the participants to provide their honest feedback, thoughts and emotions around this content as it assisted with making the instructional programming more amenable to their needs. This researcher also included reflective commentary. The reflective commentary can be devoted to the effectiveness of the technique employed (Shenton, 2004). According to Shenton (2004), transferability is the ability for results or data from one study having the ability to be applied to a wider population. Shenton (2004), also stated that it was up to the researcher to ensure that there is significant contextual information to enable the reader to make the transfer of information (Shenton 2004). In order to ensure transferability, the researcher provided a very rich detailed description of the context of the study. This description was very distinct, descriptive, and comprehensive of the environment in which my study took place encompassing my data collection methods, participants, and other pertinent information that will help in developing transferability of the study. Shenton describes the dependability as the identifying of the processes within the study being identified and shared thereby enabling a future researcher to repeat the work (Shenton 2004). In order for readers to understand my research, there will be specific sections identified to explain the research design and the way that it was implemented. In addition to this, a narrative will be provided on the details of my data gathering. In this sense, the researcher utilized the anticipated data reduction included *in* gathering or identifying data. The confirmability is recognized as the qualitative investigator's comparable concern to objectivity (Shenton, 2004). In this context, this researcher utilized triangulation to emphasize the data. I admitted my beliefs and assumptions in this study. The researcher also provided an audit trail or diagrams to support the narrative.

Chapter 4: Findings

"The secret of change is to focus all of your energy, not on fighting the old, but on building the new. - Socrates

The purpose of this chapter is to exhibit the results of the qualitative case study that was conducted to answer the following research questions:

1. How does Kotter's model impact teacher's implementation of STEM?
2. What are the support, challenges, and barriers to STEM implementation in an urban elementary school setting?

This chapter will also be inclusive of the discussion of methods that were utilized to analyze the data were aligned with the method of case study research. In addition to the aforementioned, this chapter also included a variety of demographic data related to determining the impact Kotter's Change Process has on teachers in an urban school and to identify the stage of the change process that participants are in as it relates to Kotter's Theory. Primarily this study aims to focus on identifying teacher's challenges and barriers to organizational change in the process of implementing STEM. The data collection process included participant observations, focus groups, and interviews to triangulate data. The data that were gathered provided additional meaning and context to the research questions that guided the study. The data was analyzed in a variety of ways. The data was analyzed at the ensuing levels (a) open coding, (b) theoretical framework, and (c) emotional attributes and or participants' responses.

Results

The primary unit of analysis for this study was triangulating data through observations, interviews and focus groups then analyzing this datum through ATLAS TI. Eight participants were asked 11 open ended questions (see appendix) that were related to their use of STEM instructional practices, as well as some questions in reference to their interactions and responses to change.

Process Followed

The data collection began with a round of semi structured interviews with each of the participants (see Appendix B). The interviews were structured to provide each participant a platform to discuss their interactions with STEM in their daily lives. The dates of interviews and observations by participants are listed below. In case study fashion, a journal of notes was taken as I interacted with participants. Reflexivity has the sense of reflecting on the speaker’s narrative, expressing the interviewer’s understanding of it, which is also a way of improving trustworthiness (Szymanski,2001). According to Pessoa, Harper, Santos, Carvalho, and Gracino reflexive interviews allow participants to signal agreement, suggest changes, disagree about the interpretation, supplement information or clarify obscure points that emerged upon previous contacts between interviewer and interviewee. (p.3, 2019).

Each interview document and other note was transcribed by REV, which is a digital transcription service. After the documents were transcribed, they were uploaded to ATLAS TI on a computer that was protected by a secure password. The uploaded documents were utilized in creating/identifying a hermeneutic unit. The documents and notes were also placed in a locked file cabinet in the researcher’s office in which no one else has access. Times to meet were agreed upon to conduct meetings with the participants at their convenience in order to discuss the consent forms, also to inquire if they are still willing to participate and to schedule the times for interviews and observations of STEM instruction. Immediately following the signing of the consent form, participants each designated a particular day and time for their semi structured interview as well as an observation date and time. The sequence of the two were important so that the observation was focused. Utilization of the observations were a supplemental data point that will be used to triangulate during the data collection process to provide additional support to validate the researcher's findings. The interviews were audio -recorded individually using the Olympus recording device. As a safeguard, the audio recordings were played to ensure that they matched the transcription for accuracy. Transcripts were also printed and locked in a secure file cabinet, they were also given to the participants to check for accuracy. All participants elected not to make any corrections to the transcripts. Concluding all interviews, observations were conducted. The observation tool that was utilized was the Teachers Dimension Observation Protocol also known as the TDOP (see Appendix C). The recordings were uploaded and saved on a password protected computer. The notes from the observation were scanned and uploaded to the password secured computer. For the duration of this chapter, the researcher will use excerpts that were taken from interview transcripts that will support the data interpretation. As authentic pieces of statements from the participants, there may be some spoken English that may be considered as broken. The data was transcribed and analyzed by the researcher.

Each participant will be referenced by their selected pseudonyms throughout this study. The chapter will present the findings from the data collected from the interviews and observations.

Sample

Eight participants were interviewed for this particular study. Listed in Table 4.1 are the specific participant demographics. The names in the table are pseudonyms selected by the participants. There were not any pre-requisites for participation besides being a willing participant as well as working at the selected school which is the research study site. There was a total range of experience of between 5- 25 years of teaching experience between all eight of the participants. Specifically, participants with 0-9 years of experience represented 12.5 % of the sample. The participants with 10-15 years of experience represented 50 % of the sample size. Participants with 16- 19 years of experience represented 12.5 % of the sample size. The group of participants that represented 25% of the sample size had 20 or more years of teaching experience. All participants provided their racial background. One hundred percent of the participants were African-American. Five participants, or 62.5 % were female and 37.5 % or 3 of the participants were male. Eight of the 8 participants also self-reported their level of education. Four participants or 25% reported that they were in possession of a Specialist degree or a Bachelor’s degree. 37.5% of the participants reported that they had earned a Master’s degree. One participant, or 12.5% of the participants reported that a doctoral degree was earned. The age of all participants fit between the pre- identified age group of 18-50 years of age.

They all self-selected to participate in the study. The demographic data that was collected was gender, number of years taught, grade and subject concentration, race, level of degrees, and the number of interviews completed. Sean is the only participant with one interview. He had an appointment and elected not to reschedule the 2nd interview.

Table 2 Participant Demographic Information *(n=8)*

Participant	Grade and Subject Taught	Number Years Teaching	Gender	Race	Degree	Number of Interviews
Heaven	1st Grade	20	Female	AA	Specialist	2
Lanet	2nd Grade	14	Female	AA	Masters	2
Keirston	Kindergarten	10	Female	AA	Masters	2
Kandice	5th Grade	18	Female	AA	Specialist	2
Roscoe	K-2 STEM	12	Male	AA	Bachelors	2
Vincent	3-5 STEM	8	Male	AA	Masters	2
Apple	K-3 Special Ed	10	Female	AA	Bachelors	2
Sean	K-5 Science/ Math	22	Male	AA	Doctorate	1

Data Collection

The primary method of data collection occurred through interviews, focus groups, and observations. The data that were gathered from the focus groups, interviews, and observations each served as a supporting factor for the research datum. The researcher coded the interviews after they were transcribed immediately after they were conducted. The coding was focused on theoretical framework and themes that emerged during the coding. As the researcher was collecting data, the safeguarding of case study as a research method was of highest priority. In Appendix B, the interview questions and protocol are included.

Data and Analysis: Data Analyzation

The researcher utilized case study as a methodological approach to the study. Case study research has grown in reputation as an effective methodology to investigate and understand complex issues in real world settings (Harrison, Birks, Franklin, & Mills, 2017). An interest meeting was conducted to allow interested participants to self-identity themselves as participants in the study. The researcher then scheduled interviews individually with each participant. Each interview was coded manually through open coding. Open coding refers to the first phase of the coding process conducted by the researcher doing qualitative data analysis. In qualitative data analysis, a code is generated by the researcher and represents or "translates" data (Vogt, Vogt, Gardner, & Haeffele, 2014, p. 13). This provides the coding that was completed by the researcher a meaning that was generated and understood by the researcher in order to be used at a later time during the data analysis of the qualitative research.

As the researcher takes the data and attaches a code to it, the embodiment of the meaning of the code to the research at hand has been captured in order to deduct the underlying nature of the code.

The analysis of each interview was done before moving on to conducting the next interview. As the researcher coded each interview there was analyzation for themes and or similarly identified categories. In some instances, the interviewer had to conduct clarifying questions in the midst of the interview as needed for each participant. The clarifying questions are included in the transcription of each interview and are included in the appendix.

During the next step of analysis, which is identified as selective coding, the researcher foraged to find categories that were making become evident through similarities in the open coding. Using a data analysis tool, Atlas TI the researcher created co-occurrence trees as well as identified themes.

Using Atlas TI, a computer aided qualitative analysis software, the researcher created families of codes to identify similarities in the data. The identification of open codes emerged in the data as a result. An apparent amount of theoretical coding emerged through the transcription process of the interviews, observations, and focus group. The family of codes was used to connect any relationships between codes and data. In line with the case study research design of Merriam which utilizes purposive sampling (Merriam, 1998, p.66) the participants.

This dissertation was grounded in the framework of Kotter's 8 step Theory of Change Process. Kotter's 8 step Change Process refers to the eight stages of organizational change that occur in a sequence. The eight steps of the change are as follows: create, build, form, enlist, enable, generate, sustain, and institute. The identification of participant's stance and or position in Kotter's Theory of Change is a critical aspect that must be included in this research.

Table 3 provides an alignment of the themes as they match up with the research questions that guide this study. The themes that emerged by the data collected from this study are shared in narrative format below.

Themes

The themes that emerged throughout the conducting of the interviews were: (1) instructional practices, (2) teacher leadership, (3) planning, (4) barriers and change (5) administration, (6) Supports, (7) professional learning, (8) resources, (9) financial support, (10) curriculum, (11) student background, and (12) integration. The connection to each research question as well as themes as subthemes has been outlined in Table 4.2. The table aligns the themes and their resulting connection to the research questions that are driving the study.

The evolution of these themes arrived as a result of participant's feelings and or concerns that they expressly shared throughout the study. The overarching themes are instructional practices, teacher leadership, barriers and change, and professional learning.

Table 3 Themes and Sub-themes from Research Questions

Research Question	Themes	Sub-themes
RQ1: How does Kotter's model impact teacher's implementation of STEM??	• Instructional Practices • Teacher Leadership	• Planning • Change • Administration
RQ2: What are the supports, challenges, and barriers to STEM implementation in an urban elementary school setting?	• Supports • Barriers/ Change • Professional Learning	• Resources • Financial Support • Curriculum • Student Background Knowledge • Integration

Cognitions about research question one

Research Question 1

How does Kotter's model impact teacher's implementation of STEM? Kotter's 8 STEP Process is one way to identify how participants moved through the change process in an organization. Kotter's 8 step process is the theoretical framework that grounds this study. Kotter's 8 step process has a prescriptive set of identified steps change to be successful. In the following sections I will connect my data to each step in Kotter's theoretical framework coupled with data. The first step in Kotter's change model is to establish a sense of urgency.

Data Results in Step One of Kotter's Model

The first step in Kotter's change model is to establish a sense of urgency. Bold or risky actions normally associated with good leadership are generally required for creating a strong sense of urgency (Kotter,1996, p.43). This is important as the beginning of implementation of a change beginning. Based on the behaviors outlined in Step One of Kotter's Model, Sean is the person who is leading the change and establishing the sense of urgency. According to Sean, "as we named the school after a great set of men. The importance of bringing awareness to the teachers of the importance of changing their instructional practices to hands on for the students that we serve." (Sean, Interview, March 2019).

Kotter's model begins with the leader of the school, in this case the STEM Coach. The Coach has to create a sense of urgency and communicate the immediate urgency of the change. During his interview, Sean also stated that, "STEM education is the catalyst that ignites the fire within a student's ability to solve problems." (Interview, March 2019). The actions that Sean exhibits on a daily basis as the STEM Coach demonstrate the urgency that he possesses in reference to the implementation of STEM at this urban elementary school. Sean organizes professional development for the staff on a monthly basis. In addition, he designs ways for the teachers to visit other STEM schools in order to provide them with a different perspective.

Data Results in Step Two of Kotter's Model

Step 2 in Kotter's model is to create a guiding coalition. The people in the guiding coalition are a volunteer army who are born of its own ranks. They should have a sense of power and or authority with the people they are trying to lead into the change. In this particular urban elementary school, the second step of Kotter's theory, the guiding coalition, is where participants 1, 4, and 6 exhibit themselves as a result of the interviews and observations.

Keirston proclaimed during an interview, "We are always l just looking for ways to incorporate it, figure out some kind of way that they can design something or create something or something that they can think of their own about" (Interview, March 2019)

Another participant, participant number 4 is also on Step 2 of Kotter's Model. Heaven corroborated her placement on this step by saying," I believe STEM is a way of giving that higher order thinking to those students, and to be able to let them think outside of the box during learning activities". (Interview, March 2019)

The guiding coalition, again at this school manifested itself in the form of teachers. The guiding coalition of teachers self-identified as wanting to participate in leading the change on their respective grade levels.

Data Results in Step Three of Kotter's Model

This vision must be clear and easy to follow for the other employees to be able to follow. In step 3 of Kotter's model, the leader of the change should be able to develop a vision and a strategy for the change. "If I am teaching area and perimeter, I will ask myself, what is a good PBL to teach along with area and perimeter?" (Apple, Interview, March 2019). Here Apple shows that she has a connection within her instructional delivery and practices. Apple also shares that she is the sole writer of the PBL instructional units for her grade level. Apple," I have created a robotics team. I get more students interested every Wednesday." (Focus Group, March 2019)

Roscoe said, "We are trying to STEM-ify this school. Trying to get STEM certified anyway we can" (Focus Group, March 2019). Roscoe is alluding to achieving STEM certification by any means necessary. For him, this means even going to classes teaching the lesson and or having parent events to promote STEM.

According to Vincent, "STEM is just a way of thinking and approaching the situation, for lack of better words" (Focus Group, March 2019). Vincent feels that sharing with teachers that STEM is just another way of thinking through the problems and their solutions for students.

In stage 3 of Kotter's model, which is clarifying the strategic vision, the participants are also charged to share with stakeholders how the future will be different from the past. The inefficient processes being removed allows the change to move forward.

Data Results in Step Four of Kotter's Model

In Kotter's 8 step process, step 4 is to rally a volunteer army around the change. This has manifested itself as the teachers who are gravitating towards utilizing STEM in their classrooms. These people have bought into the idea of STEM. Once this vision is identified, in Step 4 communicating the change is the step that must be taken. must then be communicated to the organization as well, this allows the communication to be open and provide employees a way to express how they are doing with the change. Sean shared, "Using STEM in classrooms is a great instructional strategy that is necessary to educate today's students for tomorrow's colleges and careers" (Interview, April 2019).

Vincent exclaimed, “In my classroom, I took writing lessons that my students created and had them create with it. They used the technology to create public service announcements” (Interview, April 2019).

Kandice shared, “I love to see my students working with STEM. They are engaged in asking questions, planning and carrying out investigations. The biggest thing is they are able to obtain and evaluate information” (Interview, March 2019).

Roscoe declared, “Students using the engineering design process to create and have a product that they have made with their own minds is rewarding for both me as the teacher and the students. They surprise themselves” (Focus Group, March 2019).

Data Results in Step Five of Kotter’s Model

In step 5, the employees were empowered to try new bold ideas; and this may require new training in order for this step to progress to the next step. In step 5 of Kotter’s 8 Step Change Process, in order for the change to become effective, barriers must be removed. The inefficient processes being removed allows the change to move forward. There was not a participant who showed themselves to be solely in Kotter’s stage 5. In contrast, there are several participants who have surpassed this stage through observations and interviews.

Data Results in Step Six of Kotter’s Model

Particularly in step 6 Kotter suggests that there is a celebration of short-term wins which will encourage the change implementers to continue with the change. The inefficient processes being removed allows the change to move forward. Step 6 of Kotter’s change model is to generate short term wins. In step 6 of Kotter’s change, volunteers need to be rejuvenated and progress shared with others. Step 6 of Kotter’s change model is to generate short term wins. In step 6 of Kotter’s change, volunteers need to be rejuvenated and progress shared with others.

Vincent shared, “I was able to bring students in to code and make something, that made me value a change in my instructional practices. This was our first time, now I get to do it again” (Focus Group, March 2019).

Another participant, Roscoe, also shared comments that placed him on Step Six of Kotter’s Model. Roscoe divulged, “At the STEM Extravaganza we were able to show parents a ZSpace, which is a 3D modeling type of computer. The parents were so excited that their students were being exposed to these types of apparatus. It felt good. We will definitely have STEM Extravaganza every year” (Focus Group, March 2019).

Data Results in Step Seven of Kotter’s Model

Considering step 7 of Kotter ‘s change process, it suggests that you consolidate gains and produce more change. During this step the leader may recognize a few short-term wins but continue towards the large-scale change. In step 7 of Kotter’s change process there needs to be some pressure applied according to the successes in order for more success to occur

One participant, Roscoe, made a statement during his interview that placed him on Step 7 of Kotter’s Change. Model. Step 7 is where the pressure is applied in order to produce more change. According to Roscoe, “Right now, we have planning periods where we discuss STEM and support the teachers with planning lessons. I may even co-teach the lessons” (Interview, March 2019).

Data Results in Step Eight of Kotter's Model

Ultimately, step 8 of Kotter's change model is to sustain the change. Lastly, in step 8 of Kotter's 8 step change process the communication of the new behaviors and the success of the organizational change must be shared in order to replace the old habits. Roscoe exclaimed, "Providing teachers with recognition and support allows them to feel as if the change is good and they also feel good because of the recognition so they keep trying to implement STEM" (Focus Group, March 2019). Roscoe also presented behaviors to be identified as being on STEP 8 of Kotter's model.

Sean stated," One of the ways to sustain the change is to use STEM as a catalyst for the learning or the application of learning through an integrated method" (Interview, March 2019).

One of the primary ways that Kotter's 8 step Change model impacts teacher's implementation of STEM is by identifying desired outcomes based on suggested identifiable behaviors. Each of the stages provides behaviors that can be noted as specific for that particular step in the change. Each participant exhibits behaviors that can be identified as being placed somewhere on the model of Kotter's 8 Step Change Process based on the descriptions of each level. Some of the research study participants are on more than one stage simultaneously. In addition, some participants were in only one stage of the process. There may not be someone in each stage based on the participant observed behaviors and interviews.

The table below, exhibits where each study participant is in Kotter's 8 Step Change Process. Placement on Table 4 is based on triangulation of observations and interview responses by research participants. The eight stages of organizational change with participants identified are represented in the following table:

Table 4 Theory of Change - Kotter's 8 Step Change Process Participant Status

Step	Participant Name	Description
1 – CREATE	Participants 1,2,3,4,5,6,7,8	Help others see the need for change through a bold, aspirational opportunity statement that communicates the importance of acting immediately.
2 – BUILD	Participants 1,2,3,4,5,6,7,8	A volunteer army needs a coalition of effective people – born of its own ranks – to guide it, coordinate it, and communicate its activities.
3 – FORM	Participants 2,3,5,7,8	Clarify how the future will be different from the past and how you can make that future a reality through initiatives linked directly to the vision.
4 – ENLIST	Participants 2,3,5,7,8	Large-scale change can only occur when massive numbers of people rally around a common opportunity. They must be bought-in and urgent to drive change – moving in the same direction.
5 – ENABLE	Participants 2,3,5,8	Removing barriers such as inefficient processes and hierarchies provides the freedom necessary to work across silos and generate real impact.
6 – GENERATE	Participants 2,3,8	Wins are the molecules of results. They must be recognized, collected and communicated – early and often – to track progress and energize volunteers to persist.
7 – SUSTAIN	Participants 2,8	Press harder after the first successes. Your increasing credibility can improve systems, structures and policies. Be relentless with initiating change after change until the vision is a reality.
8 – INSTITUTE	Participants 2,8	Articulate the connections between the new behaviors and organizational success, making sure they continue until they become strong enough to replace old habits. Information from Kotter (2012). *Leading change*

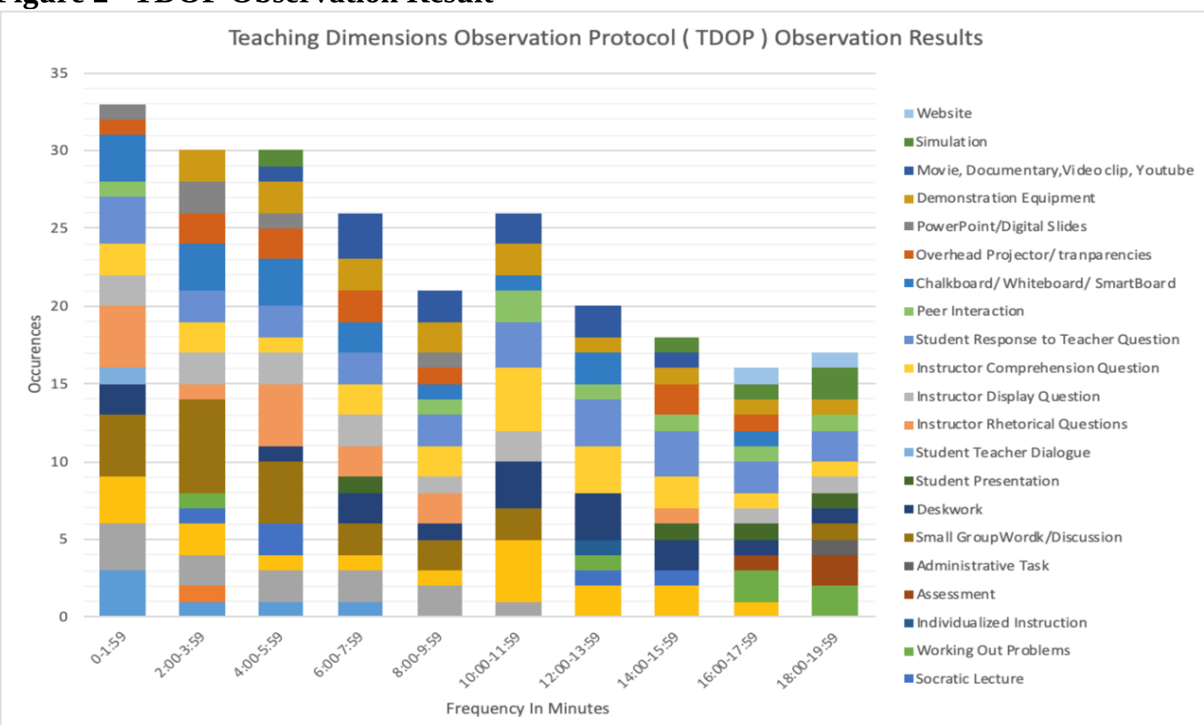
Comprehensive Summary of Classroom Observation Findings

Figure 3 below shows a compilation of the results of all observations of participants utilizing the Teaching Dimension Observation Protocol (TDOP) tool. The participants were observed for a total of 20 minutes. During the 20-minute observation time, pre-identified behaviors in each 2-minute interval were recorded by the researcher on the tool. The TDOP looked at a variety of teacher and student-centered practices in a classroom during the scheduled observation. Each 2-minute interval ascertained specific student or teacher behaviors to be coded by the observer. As the researcher conducted observations, there were three practices that were prevalent in classrooms. Lecturing with pre-made visuals was utilized by 57% of the participants. A second noted prevalent classroom practice was that 42% of the participants utilized deskwork with their students as an instructional method. Thirdly, the use of a whiteboard or smartboard as a way to display instructor pre-made questions was utilized by 42% of the stud participants. Also noted, were 3 instructional practices observed that promote inquiry and or STEM learning. Behaviors that are indicative of STEM instruction are grounded in students being afforded the opportunity to be active learners. The practice of utilizing student observation was used by 14% of study participants. Secondly, participants utilized equipment to teach a concept at the rate of 28%. Lastly, only 28% of participants utilized a simulation during their observation of STEM instruction.

In Appendix D, the individual data collected for each participant and their observation has been included. As a researcher that is focused on understanding the usage of STEM instructional practices the observation data is glaring. Utilizing the legend, there is a great deal of instructor centered instructional practices that were utilized during the observation period.

During individual interviews, participants shared that they felt that they utilized STEM instructional practices. One participant Roscoe stated, “So working with STEM, I found that students are able to grasp information because they’ll be able to work with their hands-on things, and they have been able to actually work on things that they are interested in, solving problems that really affect them and problems that they can actually experience in their day to day life” (Interview, March 27). Looking at the results of this comprehensive summary, there are limited student engagement activities being used as instructional practices. Minimal student presentation is being used as an instructional practice. Seatwork and small group work are prevalent in the instructional capture of these observations. These are both teacher-centered instructional practices. A second instructional practice that was captured often in the totality of observations was the use of rhetorical questions as an instructional method. As a result of interviews, observations, and focus group several themes were identified and connected to the collected data.

Figure 2 TDOP Observation Result



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Theme 1.1 Instructional Practices

The first theme that emerged from the data is instructional practices. Research question one, which asks, “How does Kotter’s model impact teachers’ implementation of STEM?” This theme arose from the interview responses that came from the study participants. In the interviews that were conducted, all 8 participants referenced that they had a change in instructional practices. The interview protocol (Appendix B) contained a question that asked participants how they had changed their instructional practices. A variety of responses were received from the study participants. Participants shared a variance of thoughts in reference to their instructional practices. Teachers for the most part had at least one positive experience to share about their STEM instructional practices experiences in teaching. Several comments centered themselves around tasks that students had been assigned to complete. Additional responses suggested the use of the engineering design process in the STEM experience. Teachers also discussed the inclusion of a problem in the STEM experience in which they have been involved.

One participant, Sean, shared that when initially beginning the utilization of STEM as an instructional practice and he didn’t fully explain the task at hand before engaging students, the outcome and the experiences wasn’t the best (Lines 21- 24, Interview April 2019). This encouraged the participant to revisit the plan that they had created. It also encouraged the participant to ensure that they begin with the end in mind when planning lessons for students. Another participant, Apple, stated in her interview in April 2019, “But then I said, okay well now everything is going to be hands-on, and we’re going to make it meaningful.” In sharing, Apple was reflective of the need to ensure that her students had a level of engagement in the instruction that they were receiving in the class. Problem-based or project-based instruction was also mentioned by several of the interview participants as an instructional method. All of the experiences that were reported for the most part was positive according to the teachers.

As a group, all eight of the interviewees suggested that they utilized integration as a method of implementing STEM. The integration seemingly is beginning with Reading and or Language Arts as a driving force. The majority of the teachers stated that they integrate STEM on a daily basis through the integration of a variety of content area classes. Teachers begin the integration in the planning stages before teaching the lessons to students.

Theme 1.2 Teacher Leadership

Teacher leadership is often defined as a set of practices that enhance the teacher profession according to Killion, et. al (2016). The theme of teacher leadership emerged from phrases provided by participants in the study. The participants in the study were asked about the leadership at their school being supportive of STEM. Each of the participants provided a response to the question. The responses varied based on the participant. During the focus group interview, Vincent shared, “The leader of the change has STEM in his background but to translate that down to a teacher is a whole different set of skills that may not always emerge” (Interview, April 2019).

Teacher Leadership thrives most effectively in schools where teachers and administrators share a sense of collective responsibility for the learning of all students (Killion et. al, 2016). Another respondent echoed the sentiment. Keirston, shared, “We need somebody that’s going to collaborate and show what they know and share it with us” (Interview, April 2019). Keirston is expressing the fact that she feels that the teacher leader does not share their knowledge of STEM with the teachers in a collaborative manner. According to Killion et.al (2016), teacher leaders display attitudes and behaviors that positively affect the environments in which they work, particularly the belief that all students and teachers have the capacity for growth and goal attainment.

Cognitions about research question two

Research Question Two

What are the supports, challenges, and barriers to STEM implementation in an urban elementary school setting?

According to participants, the top three important aspects that are a barrier of successful STEM implementation are resources, students not being on grade level, and professional learning.

Theme 2.1 Resources

The theme of resources was prevalent throughout the interviews of the participants. The participants feel that there is administrative support for the implementation of STEM. According to most participants there is administrative support for STEM implementation. Sean, the STEM Coach leading the change also stated, “the principal as a result of her support purchased STEMScopes curriculum for the entire staff” (Interview, March 2019). Utilizing STEM as an instructional practice was also noted as a change in practice. According to findings the participants identified the most needs as resources, these resources can be human and or material. Kandice, a participant shared during her interview, “a resource that I would love to have is the human resource of teacher’s actually teaching science and or STEM so when the students come to my grade level they have a background and are able to connect to content in my classroom for that grade level (Interview, April 2019).” Many teachers in this urban elementary school solely teach reading and mathematics as they feel these are the only two subjects that matter.

One participant, Keirston stated, “So, we need things that students can build with. We don’t have a lot of whether it is straws or blocks or whatever” (Interview, April 2019). Keirston expressed a need here for material resources needed to support STEM implementation.

Theme 2.2 Barriers and Change

The participants through self -reporting identified several things that they felt presented themselves as barriers to the successful implementation of STEM at the research study site. One apparent barrier is the perception of student ability to utilize and learn STEM at this urban elementary school. On April 26 during an interview, Lanet identified what they thought to be a barrier to change as lack of knowledge from students. Lanet stated, “We have students who are so far behind, and instead of trying to make them understand the STEM process, I would rather prefer them to be able to read fluently.” Similarly, Kandice, another respondent expressed the same concerns as it related to the students. Kandice, a participant in the study echoed Lanet’s sentiments, “Some of our students have an issue with reading on grade level” (March 2019, interview). In addition to the aforementioned excerpts, an additional respondent shared that they felt the students were not equipped to handle the demands of STEM.

Heaven stated, “One barrier that I see with students for STEM is the technology piece. A lot of the students are not equipped with all of the technology they need. During the focus group, Lanet shared, “We have a lot of students who are not where they should be” (Focus Group, April 2019). Teacher mindset as it relates to students is an important aspect as it relates to the implementation of STEM at this urban elementary school. Perceptions about student ability is one reason why the teachers are not able to move onto other steps of Kotter’s change model. There is an apparent perception that teachers possess about students that prevents them from implementing STEM.

Theme 2.3 Challenges

During both the interviews as well as the focus group, the phrase "professional learning" continually surfaced. Professional development is seen by a broad cross-section of stakeholders—teachers, principals, policymakers—as essential for instructional improvement and student learning (Borko, Elliott, & Uchiyama, 2002).

Regarding professional development, during an interview Vincent unexpectedly stated, "I noticed with some of the other teachers after that conference, after that training, they never explored that topic ever again."

Heaven shared, "Don't throw it at me and then make me do it five days a week and I really don't have a clear understanding" (Focus Group, April 2019). Another participant, Apple shared during the focus group, "we need to get so and so to come in and lead this professional development so teachers understand the engineering design process, so they actually understand how they can make it meaningful" (Focus Group, April 2019).

Kandice during an interview, shared that she received professional development outside of the school and the district that was impactful to her practice. The participant stated, "I had an opportunity to spend the week in California, spend some time with NASA working with actual engineers who implement STEM practices on a weekly basis" (Focus Group, April 2019). An opposing aspect to professional development as mentioned by Roscoe is the open mindedness of the teachers in reference to professional development. Roscoe stated, "The teacher leader provides professional development, but there are times when the teachers are not receptive because they don't want to hear from him" (Focus Group, April 2019).

Curriculum

One participant shared that there is a definite need for planning time. Roscoe related the implementation of STEM curriculum to the need for planning, stating, “I think it goes to, as mentioned by others, planning is needed to develop effective STEM curriculum. Taking more time for planning before and during” (Focus Group, April 2019). In support, according to Nagro, Fraser, and Hooks (2019), teachers are challenged daily with engaging diverse populations of students with varied individual needs to sustain learning and promote positive student outcomes.

The STEM coach, who is also the teacher leader shared, that the curriculum that has been purchased for use in this elementary school is STEM Scopes (www.stemscopes.com). Therefore, the teachers have resources such as this curriculum as well as the “Engineering is Elementary” curriculum. They have the ability to choose which curriculum they would like to implement with fidelity. The administration has spent the money to purchase these curriculums and the teachers are still saying that they do not have a STEM curriculum. The STEM coach also shared that he rarely sees either in implementation around the school.

Vincent shared that he felt the curriculum was not sufficient for the teachers to be able to change their instructional practices during the implementation of STEM at this urban elementary school. On March 27th, during an interview, Vincent stated “We are just changing the curriculum. We are changing one ineffective strategy for another ineffective strategy.”

Limitations

One of the limitations that is apparent in this study was the duration of the study. An additional limitation is the fact that the researcher is the Instructional Coach which is an assumed position of leadership in the school. An additional limitation, is if this study was replicated somewhere else, would the findings of the research have the same outcomes? The survey design is also a limitation of the study. Utilizing the exploratory case study is limited to those that are imposed by the design of the research (Yin, 2009).

A supplemental limitation to this exploratory case study is the researcher's interpretation of the data. The honesty of the participants is another possible limitation to the proposed study. In taking a deep dive into looking at STEM implementation there is not a way to make a superimposed generalization of the instructional practices in urban elementary schools. This study only looks at one urban elementary school. The sample amount of the participants can also present itself as a limitation. The number of participants can be too small of a number depending on the amount that actually participate in the full study.

Delimitations

The first delimitation that can be elucidated is the topic of the study itself. The researcher choosing change as a research topic presents a choice that was made and could have been controlled by the researcher. The researcher decided to look at change as a result of the school going through a second order change to a different instructional model. An additional delimitation that presents itself in this particular study is the choice of conducting the study in an urban elementary charter school. The urban school was chosen as a result of the researcher having daily access. Likewise, the identification of Kotter's 8 Step Change Model as a theoretical framework can posit itself as a delimitation to this study. There are a variety of theoretical frameworks related to change that the researcher had the ability to choose as a driving force for the study. Ultimately, the research questions that were utilized to drive the study subsequently presented themselves as delimitations to the research study. They were created from the view that the researcher, has in relation to the world.

Bias Disclosure

The only bias that was potentially brought into the research study by the researcher is that of being a former teacher and STEM Specialist who willingly implemented new instructional programming when it was presented to her. As a result, when observing classes, the researcher was sure to obtain a usage report. My opinion of having a growth mindset is also a bias. The researcher remains as objective and professional as possible in order to maintain the validity and reliability of the study.

Chapter 4 Summary

The problem that was addressed in this study was the resistance to change to implementing a STEM curriculum in an urban elementary school in an urban city. This study sought out to identify where the participants were on Kotter's 8 step Change process based on interviews, focus groups, and observations. According to the interviews, some participants feel that they are further along on Kotter's change model. In contrast, the observational data did not support these self-identified statuses in all participant cases. Some of the participants had a moniker of STEM practices that occurred during their observation as noted using the TDOP tool. The change from utilizing regular or non-STEM instructional practices to using STEM practices was minimal. Hall and Hord (2015) stated that, "Understanding how the change process works and how to facilitate a change is essential."

The largest and most glaring conclusion is the effect that curriculum implementors have on the success of change. Participants view of themselves as STEM implementors and where they are on Kotter's change model is vastly different based on observations and interviews. Most of the participants are still on stage 4 of Kotter's change model. After stage 4, there are only 50%

of participants left. Then as we progress to the last stages the numbers keep dwindling. Finally, at stage 8 only two of the participants went all the way through.

The participants' self -identify as STEM implementors; the observations provide evidence of mostly teacher centered instructional practices which is contradictory to this. The mindset of the teachers that are tasked with implementing this change is a barrier in itself. The teacher leader has a variety of barriers that he must walk through before getting to the level of implementation of STEM that is needed to move people through Kotter's 8 step change process and sustain the change.

This qualitative exploratory case study research project will impact the body of research by adding information on the way that a change to STEM instructional programming in an urban elementary school was conducted. Additionally, this research study will contribute to the body of research by serving as a change model for other schools going through this second order type of change. The idea of change and some of the barriers to change that are identified in this research will be able to support the readers in their walk with organizational change and possibly make it easier. As a researcher conducting this deep dive allowed me to see the connection that STEM has to a much larger audience than just the elementary school setting where the study will be conducted. As exhibited by the many references that have been shared, it is evident that STEM will be an important part of our future as a society. As a researcher, sharing the findings from this research in a narrative format may assist in providing the foundation for change in the educational setting regarding instructional programming. The importance of understanding the perceptions of teachers in the implementation of STEM in schools should be at the forefront as it may provide some insight. There are several studies related to a programming change in instructional programming in high school, but not many for this practice in elementary school which exhibits the need for this research. This case study sought out to identify the barriers to change and its effect on teacher leadership. Additionally, to instill a reflective piece to encourage change in practice for the teachers in implementing new programming. According to Riggins and Ravitch conceptual frameworks evolve and this is the evolution of any study (2017, p.75). I feel as if this one line encompasses my research journey. In addition, I have learned to be pliable and understand that change and reflection are key components in research.

The goal of this case study was to explore urban elementary school teachers' beliefs, challenges, and barrier to organizational change necessary to implement STEM curriculum. In addition to identifying these perceptions, another goal is providing them with support and opportunities to understand why changes in their instructional practices are necessary. Furthermore, the need to educate our students in an evolving educational world that has an affinity to inquiry based, hands - on science instruction. In order for teachers and school leaders to meet the needs of these 21st Century students, they must be open and willing to change. As a teacher leader in this school seeking the STEM designation, I would like to understand the reasons and transform the thinking and actions of these two groups who are so important to students through reflection.

The onset of Chapter 4 was with a brief introduction, the process that was followed, information about the sample size, and then concluded with data analysis.

Chapter 5: Discussion, Conclusions, and Implications

The purpose of this study was to investigate elementary teachers' specific place in relation to the 8 steps of Kotter's Change process, which was utilized as a framework for this study. In chapter four, analyses and results of the study were reported. Chapter five includes a summary of the study, discussion of findings, implications for practice, recommendations for further research, and conclusions.

Discussion of Findings

Research question one

This discussion in this chapter was guided by research question one, "How does Kotter's model impact teacher's implementation of STEM?" Kotter's model has a lasting impact on teacher's implementation of STEM. The model provides a guide to identify how participants in an organizational change implement the change in a variety of ways. The model provides a blueprint of sorts for the person leading the change to align teacher actions with desired outcomes. Through the use of observation as a data collection tool, the identification of teachers who were actually implementing STEM instructional practices was surprising. Participants may have self-identified as one stage of the process; however, as the researcher triangulated data the participant's actual place on the process was identified in Chapter 4 Table 4. The model will possibly impact teachers by aligning their actions with their level of commitment. Teachers who feel that they are champions for change and also exhibit these behaviors were only three out of the eight participants. When the researcher took a deeper look into Kotter's model, the leader of the change seems to be the actual leader of the school which in this case would be perceived to be the principal who is not a participant in this study. Seven of the eight participants reported that they adopted new behaviors as a result of the professional development that they received to implement STEM instruction. This was contradictory to the observations that the researcher conducted. Teachers were doing most of the talking and thinking as the researcher conducted observations. The new student center embedded behaviors are beneficial to students in the classrooms receiving the STEM instruction. In my purview, I think that participant two and eight moved the farthest through the model because of their belief in students from the beginning. In an article by Reinhorn, Johnson and Seimon (2018), growth mindset was described as – "expecting and embracing the idea of developing knowledge and skills over time, rather than assuming individuals are born with fixed abilities (p.1). This mindset is a contributing reason why participants number 2 and 8 made it all the way through Kotter's model. As the change steps unfolded and unlocked different dimensions others became interested and engaged; which continued to fuel the energy for participants two and eight. The other participants that did not move forward throughout the change process had a fixed mindset. A fixed mindset is when there is a view of intelligence as unhanging (Seaton, 2018, p.42). The fixed mindset is one of the largest factors that restricted the other 6 participants from moving forward in the steps of change. In addition to their apparent fixed mindsets, teacher beliefs are a contributing factor to the reasons that the other participants did not move any further in Kotter's Change Model. Farrell and Ives (2014) have noted, beliefs are often held tacitly and remain hidden to teachers although they have a powerful impact on their practice (p.1). The factors that I feel were significant were the realization of the students thinking differently and adapting to the STEM integration when they did receive the instruction in that manner. Students from this school have begun to be recognized at the district and state level for their science endeavors.

Empowering teachers to go to external STEM Workshops and have them come back to train others would be a way to build the STEM capacity at this elementary school. The train-the-trainer model would create a cadre of teacher leaders and build the STEM instructional toolbox in tandem. The instructional leader that makes the monetary decisions can set aside some money in the school budget so that this can occur. In addition, the people who attend conferences can go to break-out sessions and then come back to their schools and use the train-the-trainer model for the teachers at the school who did not go to the conference. The STEM leader can also conduct lunch-and-learn sessions at the school during the teacher's lunch periods and they can attend on a voluntary basis. This would close some gaps and strengthen relationships between the STEM Leader and the teachers.

In a chart created by Borrego and Henderson (2014) they listed that there are four categories of change strategies (p.224). According to the authors each category is closely aligned with a different community of professionals. Borrego and Henderson share that we know that certain approaches are a better fit for certain situations (2014). Borrego and Henderson suggest that there are two dimensions to change. One is the aspect of the system that you will be changing and the other is the outcome that is intended. This chart has primarily been targeted for use by schools in higher education. The first criteria that is identified is the environment and the structure. As this relates to the current study, the structure of the instructional program is changing from teacher directed instructional practices to STEM and student directed instructional practices. The second criteria focus is on the outcomes of the change. There are two categories of outcomes that can emerge based on the chart. The two categories are prescribed outcomes and emergent outcomes. In the article by Borrego and Henderson, a prescribed outcome is using a specific set of curricular materials, textbook, technology or assessment tool (2014, p.223). In the current study by the researcher, the outcome would be emergent. An emergent outcome comes about as the change is occurring. As the process of implementing STEM instruction was happening, so were the changes.

We do not have a systematic way of thinking about which change perspectives are most appropriate in any given situation (Borrego and Henderson, 2014 p.223). Systemic Change as it relates to organizational change in STEM departments according to Reinholz and Apkarian (2018) consists of four frames. These four frames will work in tandem to develop a successful implementation of change at the higher education level. Sustainable change requires attending to and changing the structures that define a department (Reinholz and Apkarian, 2018, p.3). The four frames of systemic change as shared by Reinholz and Apkarian (2018) are structures, symbols, people and power. Structures are roles, responsibilities, practices, routines and incentives that organize how people interact according to Reinholz and Apkarian (2018 p.3). Relating this to the current research study, this one component is the epicenter of the case at hand. These “formal” positions define what constitutes a department and or a STEM leadership team in the case of this research site. The classroom routines such as instruction was an intricate part of the structures as defined by the authors that needed to go through a systemic change.

Research question two.

Some interesting discussion of findings was based on research question two: What are the supports, challenges, and barriers to STEM implementation in an urban elementary school setting? The supports, challenges, and barriers that were identified as the top 3 based on a query of phrases through Atlas Ti were resources, students not being on grade level, and professional development. As participants spoke about resources, there were a myriad of references to what they considered resources. Resources that were identified were both human resources as well as tangible ones. “A lot of times, we don’t have a lot of material or resources to do that” (March 26, Keirston, line 71). In this quote, Keirston was simply referring to STEM building materials such as straws and materials to build a floating boat. To build this model, Kierston would have needed aluminum foil, foam plastic and any items that students could have experienced the sink or float lesson. When referencing human resources, teachers were suggesting that there be an additional person teaching in their class to support them in implementing STEM instructional practices.

Additionally, the level of students that the teachers have been charged with teaching, according to the teacher's opinions, they (the students) do not always come with a plethora of background knowledge and this too has been cited as a barrier to implementing STEM.

Receiving shoulder to shoulder support from the STEM Coach and or STEM Teacher has also been identified as a "needed resource" by several participants. Teachers feel as if the STEM instructional coach being more hands on in classes as a second set of hands is a resource that they would like to receive. In addition to the human and material resources, participants identified obtaining a particular curriculum as a needed resource. This is uncanny as the principal has invested more than $15,000 for the "STEM Scopes" curriculum to be implemented with fidelity. This is inclusive of online access to curriculum and materials to perform all STEM related activities in all classes K-5. Challenges that were identified by some of the study participants were that students did not come with enough background and or prior knowledge. This was disturbing as it presented that teachers already had a pre-conceived notion of the capabilities of the students that they were charged with educating. Teachers entering a change with a stereotypical preconceived mindset is a surefire way for a change not to occur.

Recommendations for the School Teachers

As a school teacher embarking on a change, have an open mind about the upcoming change. There are several mindsets that occur along with organizational change. Razzetti (2019) shares that you can exhibit an appreciative mindset which entails thinking about high points in the organization. High points, are when there is the most engagement. Think about how the change can be beneficial to your pedagogical toolbox. Think about how there are some aspects of the change that are bite sized changes that you can implement instantly. In the role of school teacher, think about some habits of mind that you can transfer from the change to other content areas to accept the change in instructional practices. In addition, as a teacher be proactive and participate in the new curriculum implementation or adoption. Other change implementors and leaders of the change can benefit from viewing the change from the classroom perspective.

The utilization of the components as a way to increase student engagement is a final recommendation from the researcher. Students should be constantly asking and answering questions generated by the students themselves using creativity, problem solving, as well as using metacognition in their day to day instructional activities.

Recommendations for the Teacher Leader

There are several recommendations for teacher leaders from the researcher. The role of teacher leadership would greatly benefit from having pre-identified roles and responsibilities in the school. If this role is in an urban school, outline how the role and responsibilities will differ based on the student population that you will be serving who typically come to school with a variety of needs.

In addition to the roles and responsibilities of teacher leader, have a cadre of people to assist with planning out the change that you would like to implement. This will assist with getting buy-in from other departments and vantage points. Establish a professional learning community around the learning, in this case STEM so that teachers can build capacity from each other. A paramount indicator for the teacher leader is to build in an accountability piece in any endeavor for teachers. In the role of teacher leader which is sometimes a mediator, bridge the gap between the teachers and the building administration. Lastly, be sure to focus on the ultimate goal which is student achievement and growth this can be in the form of closing the achievement gap. Ensuring that strong relationships are built with teachers will also support the work and encourage teacher to want to be a part of the new change.

Recommendations for School Administration

The researcher suggests that the school administration actually lead the learning, when there is a new initiative being employed. This allows for the staff to feel as if they are speaking the same language as the leadership. Supplementally, it sets expectations that we are all in this work together. If as school administration, you don't have a great deal of knowledge about the topic do some research so that you are knowledgeable about what is being asked of your team members. Understanding what "STEM" is will provide you with credibility. During your research and implementation of STEM, identify some STEM leadership dispositions. This may manifest itself as opening staff meetings with a STEM challenge. Opening the meeting with the STEM challenge will allow teachers to see how much fun STEM can be and how their students persevere through the challenges as administrators popping into classes and teaching a lesson will also show teachers that not only are you all in for the organizational change, you support them and their hard work. Finally, designating and earmarking funding in your budget for ongoing and content focused professional development for all staff.

Recommendations for School Districts

As a school district, identifying needed resources for schools seeking the STEM designation so that they all have the same roadmap to success. Earmark dollars for sustained professional development in the signature programming budget for the whole district. Another added layer to this organizational change can be the creation of a district or regional level liaison for the teacher leaders as well as administrators to provide navigation and possible guidance in the process. Districts can create an instructional pathway by school level for students to obtain continuous support throughout elementary, middle, and high school. Providing students with a path that is consistent and continuously focused on the signature program that the cluster and or region has identified as its goal for certification. Ultimately, school districts also have an opportunity to establish long standing relationships with community partners and post-secondary institutions.

Recommendations for Universities and Teacher Preparation Programs

The researcher recommends that the Universities and Teacher Preparation Programs include STEM teaching dispositions in their program and content pre-service instructional strategies classes. This will allow graduates to come to school more prepared and readier to serve students and work alongside veteran teachers. Further, in order to prepare Pre-service teachers for work in STEM Urban schools they need to have the ability to support students in navigating their everyday reality in tandem with success at school. Furthermore, teacher preparation programs engaging their students in attaining the skillset to navigate content, engagement, and technology simultaneously.

Implications for the field of Teacher Leadership

The implications for the field of Teacher Leadership as it relates to the implementation of an organizational change is varied. One implication is to ensure that as the teacher leader you are aware of the variety of ways that those under your leadership learn. The teacher leader can be sure to be aware of the employees. As told by Hiatt and Creasey (2005), a main focus of organizational change management, employees are often neglected when it comes to building competency in change (P.85). Based on the findings, it appears that most of the teachers are on stage 4 of Kotter's Change Process. The teacher leader must remember that the process part of the change must not outweigh the human part (Hiatt & Creasey, 2005).

An apparent implication for the field of Teacher Leadership is the need for more training. Both the leader of the change as well as those that they are leading need constant and relevant professional development. A next step for a teacher leader is to implement systemic approach utilizing the 3D instructional practices that align with the Next Generation Science Standards. The 3D practices will improve content, students will utilize the science and engineering practices, and the crosscutting concepts. According to Killion et. al, (2016), there are 4 steps that make up a system of teacher leadership. The components are definition of teacher leadership purpose, roles and responsibilities. Component 2 creation of conditions for successful teacher leadership. Component 3 cultivation of dispositions for teacher leadership, and component 4 assessment of the impact of teacher leadership. The understanding of andragogy, which is the adult learning theory can be a next step for teacher leadership.

Final Thoughts and Conclusion

Teacher Leadership and its ability to have lasting impact in the field of education is heavenly determined by the willingness and open-mindedness of those that they lead. Having the ability to change the trajectory of a student and or a school by having the best team players on their side. This is inclusive of having the budget to send teachers to needed training, having the release time to be able to provide them with shoulder to shoulder support, and having the support system that has bought into the change and understands the ramifications of the change. Some next steps that I think would be wins for the field of teacher leadership is providing these leaders with the ability to select the teachers and staff members that will be implementing STEM in the classrooms that they will be supporting. One surefire way to be able to successfully implement a change is to have teachers with a positive perception and belief in the students that they will be serving. Teachers who will work with urban students must understand the needs of the student population that they will be working with. The work of teacher leadership is often undefined, unsupported, and sometimes unrecognized and undervalued, thus limiting the potential for positive impact (Killion et. al, 2016). In addition, each school and the implementors of change should identify what they feel that each phase of the change should look like. As they identify the levels of change, identifying success criteria at each change will help. Placing time stamps and completion markers can support the work. An additional next step for this particular school who is looking to implement curricular change is to identify the 5E model as the lesson plan of choice in order to undergird the structure of the lesson development and delivery.

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Appendix A Teaching Dimensions Observation Protocol (TDOP)

Teaching Dimensions Observation Protocol

TDOP – Basic Version

(This template includes ALL codes for 3 Basic Dimensions; see tdop.wceruw.org to download this and other templates or to download a blank form to which you can then add columns for additional Dimensions and/or populate with desired codes)

Directions: Circle codes for each behavior observed during every two-minute interval. Take detailed notes about aspects of the class that is of particular interest for your application (e.g., content discussed, nature of student dialogue).

Interval #	1	2	3	4	5
Min	0-1:59	2:00-3:59	4:00-5:59	6:00-7:59	8:00-9:59
Instruct. Practices – Teacher-focused	L LW LVIS LDEM SOC-L WP IND MM A AT	L LW LVIS LDEM SOC-L WP IND MM A AT	L LW LVIS LDEM SOC-L WP IND MM A AT	L LW LVIS LDEM SOC-L WP IND MM A AT	L LW LVIS LDEM SOC-L WP IND MM A AT
Instruct. Practices – Student-focused	SGW DW SP	SGW DW SP	SGW DW SP	SGW DW SP	SGW DW SP

Notes :

Student-Teacher Interactions Teacher-led	IRQ IDQ ICQ	IRQ IDQ ICQ	IRQ IDQ ICQ	IRQ IDQ ICQ	IRQ IDQ ICQ
Student-Teacher Interactions Student-led	SQ SR PI	SQ SR PI	SQ SR PI	SQ SR PI	SQ SR PI

Notes:

Instructional Technology	CB OP PP CL D DT M SI WEB	CB OP PP CL D DT M SI WEB	CB OP PP CL D DT M SI WEB	CB OP PP CL D DT M SI WEB	CB OP PP CL D DT M SI WEB

Notes:

Teaching Dimensions Observation Protocol

Interval #	6	7	8	9	10
Min	10:00-11:59	12:00-13:59	14:00-15:59	16:00-17:59	18:00-19:5
Instruct. Practices – Teacher-focused	L LW LVIS LDEM SOC-L WP IND MM A AT	L LW LVIS LDEM SOC-L WP IND MM A AT	L LW LVIS LDEM SOC-L WP IND MM A AT	L LW LVIS LDEM SOC-L WP IND MM A AT	L LW LDEM SO WP INI MM A
Instruct. Practices – Student-focused	SGW DW SP	SGW DW SP	SGW DW SP	SGW DW SP	SGW D SP

Notes :

Student-Teacher Interactions Teacher-led	IRQ IDQ ICQ	IRQ IDQ ICQ	IRQ IDQ ICQ	IRQ IDQ ICQ	IRQ II ICQ
Student-Teacher Interactions Student-led	SQ SR PI	SQ SR PI	SQ SR PI	SQ SR PI	SQ SR PI

Notes:

Instructional Technology	CB OP PP CL D DT M SI WEB	CB OP PP CL D DT M SI WEB	CB OP PP CL D DT M SI WEB	CB OP PP CL D DT M SI WEB	CB OP CL D M SI

Notes:

TDOP Version 2.1: Revised August 2014

TDOP Teaching Dimensions Observation Protocol

Post-Observation Field Notes

Note any over-arching observations about the class just observed or any specific incidents or activities that ar
elaborating upon. Also keeping in mind the purpose of the evaluation, make summative observations about tl
Finally, if a post-class survey such as the RTOP or Teaching Behaviors Inventory (TBI) is of interest in order
the efficacy of the class, administer the survey at this point.

Appendix B- Interview Protocol

Interview #

Date:

Time:

Location:

Interview Script

Welcome and thank you for your participation today. My name is Shelante' Patton and I am a doctoral student at Kennesaw State University conducting research for my dissertation. This interview should take between 60 -75 minutes and will include 30 questions regarding your experiences with STEM implementation. You may share any information that you feel is pertinent. I will be using an audio digital recorder to ensure that I do not miss any valuable information from our talk. If at any time during the interview you wish to discontinue the use of the recorder or the actual interview itself, please feel free to let me know and we will stop. All of your responses will be kept confidential. Your responses will remain confidential throughout the study and your names and will be changed upon the writing up of the study findings.

At this time, I would like to take the time to graciously thank you for your written consent and alert you that your participating in this interview also implies your consent. Your participation in this interview is completely voluntary. If at any time you want to stop, or go back to a previous question please let me know. Do you have any questions before we begin the interview? With your assent, we will begin our interview talk.

Questions related to STEM

1. How long have you been teaching? At this school? In this district?
2. How and when are content areas integrated into your instructional practices?
3. Share a positive experience that you have had with using STEM in your instruction.
4. Tell me what influences your decision to integrate STEM in lessons?
5. Thinking of all of the training that you have had to integrate STEM. What is one thing that has stuck with you? And why?
6. Do you value STEM integration as an instructional practice?
7. How do you feel that you handle change? What processes do you take when change occurs?
8. What are the supports or barriers that you see as it relates to STEM in reference to your students?
9. Have you implemented any change in instructional practices since you have been trained on STEM instructional practices? If so, please provide an example?
10. Do you think the leadership at your school is supportive of STEM? If so, why or if not why not? Are they encouraging the STEM culture with staff and students if so , why if not, why not?
11. As we began to finalize this interview session, is there any other information that you would like to provide me with?

Appendix C – Participant Consent Form

Signed Consent Form

Title of Research Study (#19-364): Elementary School Teacher's Challenges and Barriers to Organizational Change and STEM Implementation: Factors Impacting Teacher Leadership
Researcher's Contact Information: Name, Telephone, and Email
Shelante' Patton
Spatton5@students.kennesaw.edu
678-516-2888

Introduction

You are being invited to take part in a research study conducted by Shelante' Patton of Kennesaw State University. Before you decide to participate in this study, you should read this form and ask questions about anything that you do not understand.

Description of Project

The purpose of this study is to investigate Teacher's position in Kotter's change process as it relates to implementing STEM instruction as perceived by elementary educators in an urban school in a large urban school district. The reason this is important is because the teachers are the implementers of the change and how they see or perceive barriers to implementing the change in instructional programming is incumbent upon the success of the outcome of the programming change.

Explanation of Procedures

Participants will be asked questions about how they feel about STEM, changing instructional practices, and their comfort level with implementing STEM. The study is a qualitative case study conducted in a STEM Education and Leadership discussion which focused on in depth questions including such revealing questions as, "What is STEM?" and "Do you think that STEM education is important?". There will also be Focus Group discussions in order to gather more information on opinions, beliefs, and attitudes toward the research topic. Sessions will be video recorded and then transcribed. After themes are identified the data is coded and triangulated. The results will be analyzed and shared.

Time Required

Each interview will take place at a time and location that is convenient for the participant. The tasks that the interviewee will participate in will take a total of two to three hours in their totality and occur one month apart.

Risks or Discomforts

There is no minimal risk or discomfort to the participants. According to the federal regulations at **§46.102(i)**, *minimal risk* means that the probability **and** magnitude of harm or discomfort anticipated in the research are not greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests.

Benefits

When we identify the reasons that teacher's perception to changes in instructional programming that can assist their students with critical thinking, we can offer a reflective piece in order to transform their instructional thinking and actions. In addition to the aforementioned, the contributions of the participants will help other teachers to support the use and implementation of STEM instruction in schools.

Compensation
There is no monetary compensation nor any gifts.

Confidentiality
The results as well as participation in this study will be anonymous. The participants' confidentiality will be maintained at all times through the use of pseudonyms. There will not be any identifying information connecting the collected data to any participants

Inclusion Criteria for Participation

All participants must be at least 18 years of age to participate in the study.
Participant age range: __28- 50_

Signed Consent

I agree and give my consent to participate in this research project. I understand that participation is voluntary and that I may withdraw my consent at any time without penalty.

____
Signature of Participant or Authorized Representative, Date

____
Signature of Investigator, Date

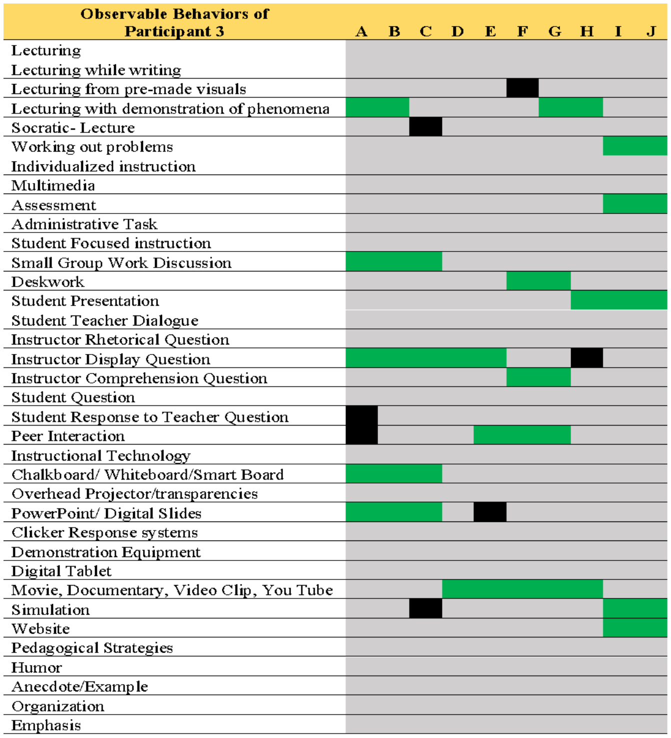
PLEASE SIGN BOTH COPIES OF THIS FORM, KEEP ONE AND RETURN THE OTHER TO THE INVESTIGATOR

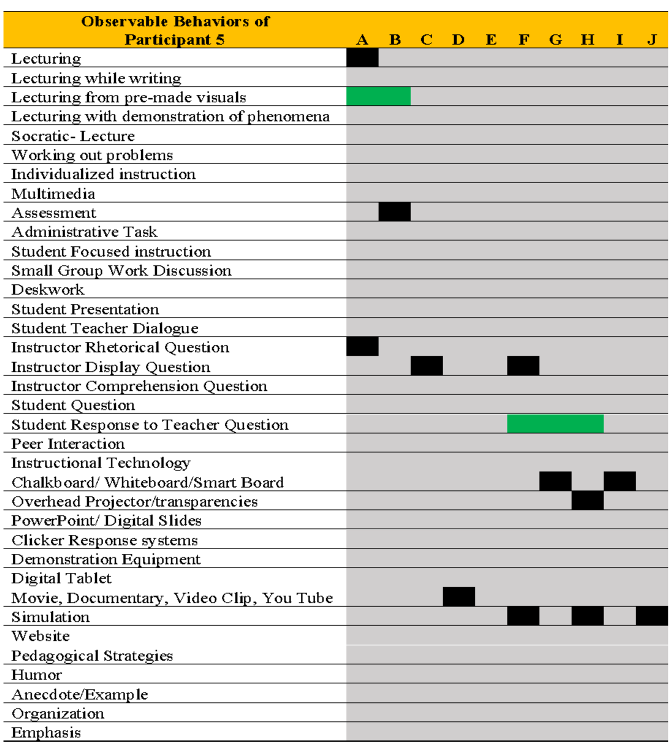
Research at Kennesaw State University that involves human participants is carried out under the oversight of an Institutional Review Board. Questions or problems regarding these activities should be addressed to the Institutional Review Board, Kennesaw State University, 585 Cobb Avenue, KH3403, Kennesaw, GA 30144-5591, (470) 578-2268.

Appendix D – Participant Observations

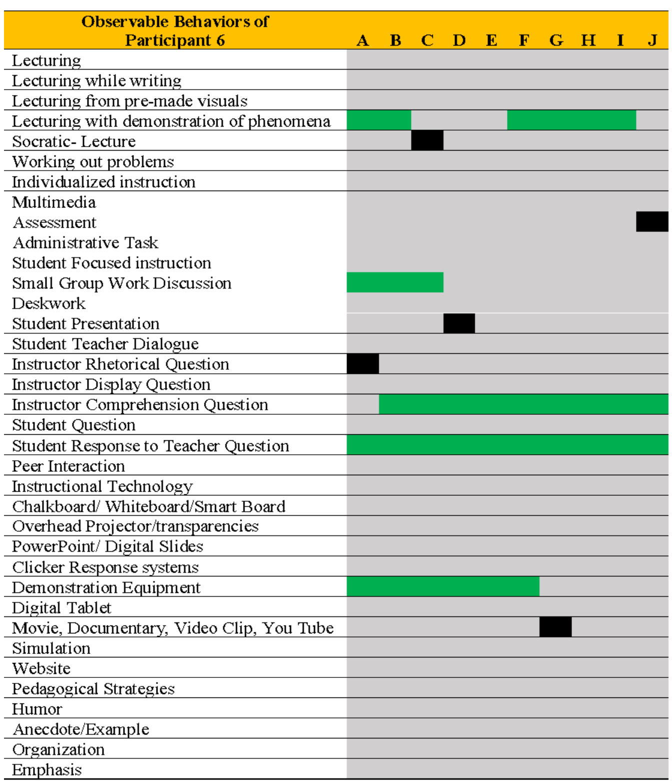
Observable Behaviors of Participant 1	A	B	C	D	E	F	G	H	I	J
Lecturing										
Lecturing while writing										
Lecturing from pre-made visuals										
Lecture with demonstration of phenomenon										
Socratic- Lecture										
Working out problems										
Individualized instruction										
Multimedia										
Assessment										
Administrative Task										
Student Focused instruction										
Small Group Work Discussion										
Deskwork										
Student Presentation										
Student Teacher Dialogue										
Instructor Rhetorical Question										
Instructor Display Question										
Instructor Comprehension Question										
Student Question										
Student Response to Teacher Question										
Peer Interaction										
Instructional Technology										
Chalkboard/ Whiteboard/Smart Board										
Overhead Projector/transparencies										
PowerPoint/ Digital Slides										
Clicker Response systems										
Demonstration Equipment										
Digital Tablet										
Movie, Documentary, Video Clip, You Tube										
Simulation										
Website										
Pedagogical Strategies										
Humor										
Anecdote/Example										
Organization										
Emphasis										

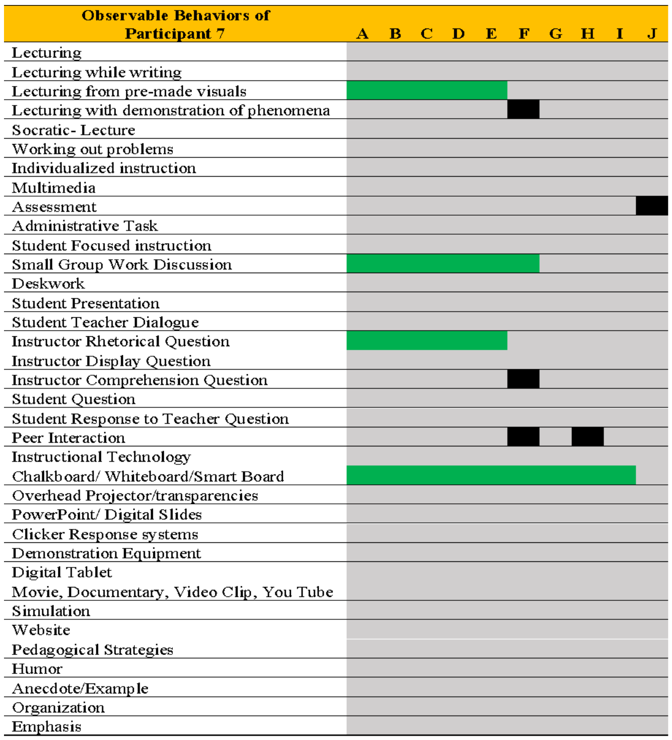
Observable Behaviors of Participant 2	A	B	C	D	E	F	G	H	I	J
Lecturing										
Lecturing while writing										
Lecturing from pre-made visuals										
Lecturing with demonstration of phenomena										
Socratic- Lecture										
Working out problems										
Individualized instruction										
Multimedia										
Assessment										
Administrative Task										
Student Focused instruction										
Small Group Work Discussion										
Deskwork										
Student Presentation										
Student Teacher Dialogue										
Instructor Rhetorical Question										
Instructor Display Question										
Instructor Comprehension Question										
Student Question										
Student Response to Teacher Question										
Peer Interaction										
Instructional Technology										
Chalkboard/ Whiteboard/Smart Board										
Overhead Projector/transparencies										
PowerPoint/ Digital Slides										
Clicker Response systems										
Demonstration Equipment										
Digital Tablet										
Movie, Documentary, Video Clip, You Tube										
Simulation										
Website										
Pedagogical Strategies										
Humor										
Anecdote/Example										
Organization										
Emphasis										

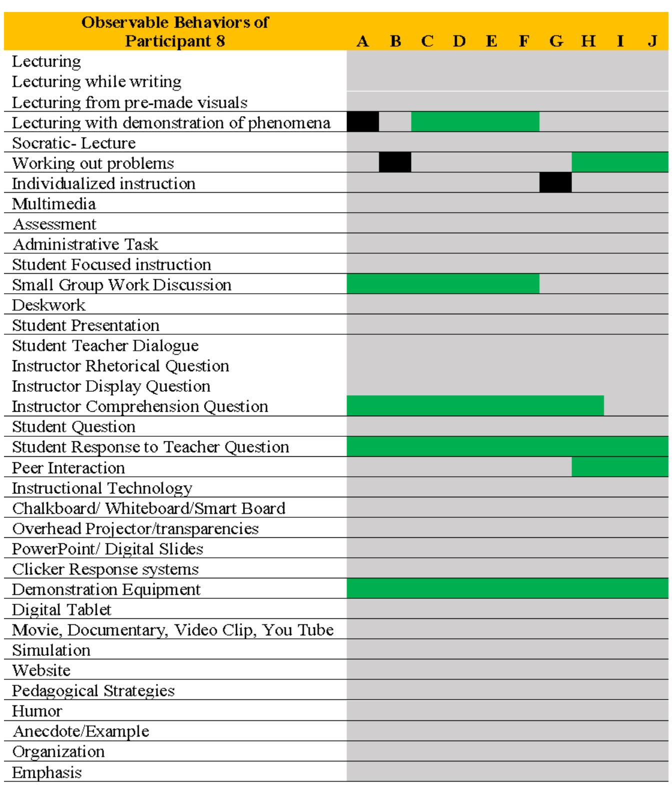

Observable Behaviors of Participant 3
A B C D E F G H I J
Lecturing
Lecturing while writing
Lecturing from pre-made visuals
Lecturing with demonstration of phenomena
Socratic- Lecture
Working out problems
Individualized instruction
Multimedia
Assessment
Administrative Task
Student Focused instruction
Small Group Work Discussion
Deskwork
Student Presentation
Student Teacher Dialogue
Instructor Rhetorical Question
Instructor Display Question
Instructor Comprehension Question
Student Question
Student Response to Teacher Question
Peer Interaction
Instructional Technology
Chalkboard/ Whiteboard/Smart Board
Overhead Projector/transparencies
PowerPoint/ Digital Slides
Clicker Response systems
Demonstration Equipment
Digital Tablet
Movie, Documentary, Video Clip, You Tube
Simulation
Website
Pedagogical Strategies
Humor
Anecdote/Example
Organization
Emphasis


Observable Behaviors of Participant 5
A B C D E F G H I J
Lecturing
Lecturing while writing
Lecturing from pre-made visuals
Lecturing with demonstration of phenomena
Socratic- Lecture
Working out problems
Individualized instruction
Multimedia
Assessment
Administrative Task
Student Focused instruction
Small Group Work Discussion
Deskwork
Student Presentation
Student Teacher Dialogue
Instructor Rhetorical Question
Instructor Display Question
Instructor Comprehension Question
Student Question
Student Response to Teacher Question
Peer Interaction
Instructional Technology
Chalkboard/ Whiteboard/Smart Board
Overhead Projector/transparencies
PowerPoint/ Digital Slides
Clicker Response systems
Demonstration Equipment
Digital Tablet
Movie, Documentary, Video Clip, You Tube
Simulation
Website
Pedagogical Strategies
Humor
Anecdote/Example
Organization
Emphasis


Observable Behaviors of Participant 4
A B C D E F G H I J
Lecturing
Lecturing while writing
Lecturing from pre-made visuals
Lecturing with demonstration of phenomena
Socratic- Lecture
Working out problems
Individualized instruction
Multimedia
Assessment
Administrative Task
Student Focused instruction
Small Group Work Discussion
Deskwork
Student Presentation
Student Teacher Dialogue
Instructor Rhetorical Question
Instructor Display Question
Instructor Comprehension Question
Student Question
Student Response to Teacher Question
Peer Interaction
Instructional Technology
Chalkboard/ Whiteboard/Smart Board
Overhead Projector/transparencies
PowerPoint/ Digital Slides
Clicker Response systems
Demonstration Equipment
Digital Tablet
Movie, Documentary, Video Clip, You Tube
Simulation
Website
Pedagogical Strategies
Humor
Anecdote/Example
Organization
Emphasis


Observable Behaviors of Participant 6
A B C D E F G H I J
Lecturing
Lecturing while writing
Lecturing from pre-made visuals
Lecturing with demonstration of phenomena
Socratic- Lecture
Working out problems
Individualized instruction
Multimedia
Assessment
Administrative Task
Student Focused instruction
Small Group Work Discussion
Deskwork
Student Presentation
Student Teacher Dialogue
Instructor Rhetorical Question
Instructor Display Question
Instructor Comprehension Question
Student Question
Student Response to Teacher Question
Peer Interaction
Instructional Technology
Chalkboard/ Whiteboard/Smart Board
Overhead Projector/transparencies
PowerPoint/ Digital Slides
Clicker Response systems
Demonstration Equipment
Digital Tablet
Movie, Documentary, Video Clip, You Tube
Simulation
Website
Pedagogical Strategies
Humor
Anecdote/Example
Organization
Emphasis


Observable Behaviors of Participant 7
A B C D E F G H I J
Lecturing
Lecturing while writing
Lecturing from pre-made visuals
Lecturing with demonstration of phenomena
Socratic- Lecture
Working out problems
Individualized instruction
Multimedia
Assessment
Administrative Task
Student Focused instruction
Small Group Work Discussion
Deskwork
Student Presentation
Student Teacher Dialogue
Instructor Rhetorical Question
Instructor Display Question
Instructor Comprehension Question
Student Question
Student Response to Teacher Question
Peer Interaction
Instructional Technology
Chalkboard/ Whiteboard/Smart Board
Overhead Projector/transparencies
PowerPoint/ Digital Slides
Clicker Response systems
Demonstration Equipment
Digital Tablet
Movie, Documentary, Video Clip, You Tube
Simulation
Website
Pedagogical Strategies
Humor
Anecdote/Example
Organization
Emphasis


Observable Behaviors of Participant 8
A B C D E F G H I J
Lecturing
Lecturing while writing
Lecturing from pre-made visuals
Lecturing with demonstration of phenomena
Socratic- Lecture
Working out problems
Individualized instruction
Multimedia
Assessment
Administrative Task
Student Focused instruction
Small Group Work Discussion
Deskwork
Student Presentation
Student Teacher Dialogue
Instructor Rhetorical Question
Instructor Display Question
Instructor Comprehension Question
Student Question
Student Response to Teacher Question
Peer Interaction
Instructional Technology
Chalkboard/ Whiteboard/Smart Board
Overhead Projector/transparencies
PowerPoint/ Digital Slides
Clicker Response systems
Demonstration Equipment
Digital Tablet
Movie, Documentary, Video Clip, You Tube
Simulation
Website
Pedagogical Strategies
Humor
Anecdote/Example
Organization
Emphasis